PHYSICO-CHEMICAL AND BIOLOGICAL ANALYSIS OF RIVER KEN IN BANDA DISTRICT

THESIS

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CERTIFICATE

It is hereby certified that the thesis entitled **"Physico-Chemical and Biological Analysis of River Ken in Banda District"** is being submitted to the Bundelkhand University, Jhansi (U.P.) by Mr. Kundan Singh for the award of the degree of Doctor of Philosophy in Zoology. He worked under my guidance and supervision and the candidate has put in an attendance of more than two years with me.

To the best of my knowledge and belief the thesis, embodies the work of the candidate himself. It fulfils all the reguirement of the ordinance relating to the Ph.D. degree of the University.

Thesis is standard one both in the respect of contents and language. It is referred for the evaluation by the examiners.

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DECLARATION

I hereby declare that the thesis entitled **"Physico-Chemical and Biological Analysis of River Ken in Banda District"** is completed by me under the kind guidence and supervision of DR. K.V. Singh Ex. Reader and Head of the Deptt. of Zoology Pt. J.N.P.G. College, Banda. This is submitted to the Bundelkhand University, Jhansi (U.P.) in fulfilment of the requirment for the award of the degree of Ph.D.. This Thesis is my original piece of work. Any part of it or thesis has not been previously published or submitted for the award of any degree.

As regards the literature concerned Journals etc. were consulted in libraries of Sagar, Lucknow, Chhatrapati Sahuji Maharaj, C.S.A. Kanpur and Allahabad Universities. I participated in U.G.C. National seminars in which I presented two research papers "Management and Utilization of Aquatic Weeds In Human Welfare" and "Physico-chemical and Manuring Qualities of Vermicompost and its Uses in Organic Farming".

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INTRODUCTION

INTRODUCTION

The entire globe is unique, having an abundance of aquatic ecosystem in the form of oceans, rivers, reservoirs, lakes, ponds, tanks and other small water bodies. The water is referred as hydrosphere which covers 71% of the total surface area of the earth. Therefore, the earth is sometimes called a 'watery planet'. Continents may be considered as large island rising from the vast oceans. Water occurs on the land in the form of ice-sheets in polar-regions and on high mountains and it occurs in the form of water vapours in the lower layer of the atmosphere. Water also occurs below surface of the land in the form of underground water. Of the total volume of water available 97% in the vast oceans, 2% is stored in the form of ice-sheets and less than 1% is available as fresh water.

Differential heating by the sun is responsible for the circulation of water in the hydrosphere, similar to the circulation of air in the atmosphere. When the surface water in the oceans, rivers, lakes etc. gets heated by the sun's rays, evaporation takes place and water vapours are added on to the lower layers of the atmosphere which are cooled leading to condensation of water into tiny droplets to form clouds, such clouds cause precipitation of water in the form of rainfall or snowfall on the surface of the earth. Due to rainfalls the surface run-off of water in rivers which reach the oceans, ultimately. During this course water is consumed by plants and animals in the biosphere. Besides, water is also stored on the land in the form of lakes, ponds, tanks etc. It is also temporarily stocked in the form of ice-sheets. The water strata i.e. underground water level depends on the nature of the rains. This circulation of water between hydrosphere, atmosphere and lithosphere

is the 'hydrological cycle'. The rate of this cycle between surface and atmosphere is very rapid. The average annual rainfall on the earth is about 81.1 cm. (Furon, 1967).

Water plays an important role in sustaining various forms of life on the earth. Infact water is a pre-condition of life. It is also being put to use for various industrial and agricultural purposes and thermal power generation.

Water is an inexhaustible gift of nature. However, its uneven distribution in space and time has often threatened human welfare, livelihood and economic development.

The growing scarcity of water has been the result of rapidly growing population, rising demand for food and cash crops, increasing urbanization and industrialization for rising standard of living. These will increase the acuteness of the problem of water scarcity in future.

In context to the Indian subcontinent an extensive repository of literature is available which deals with composition of natural and polluted waters (Singh 1989, Trivedy 1988). However, because of the different rates of solubility of the rocks and soils in different catchment areas, seasonal and daily variations of the run-off or rainfall and the contribution of ground water, rivers have widely varying compositions, than infact expected.

The last ten years have witnessed the publication of numerous articles reporting on the precarious nature of the Himalayan aquatic environment and the increasing stress upon its components (Rawat 1988, Kumar & Singh 1989). Aquatic environment are among modified habitats as a consequence

of industrial development. Since water is the source of most requirements for fish. Any impairment to the living medium is likely to adversely affect their entire life.

We use the rivers lakes, ponds and streams to satisfy our domestic, industrial, transport and sporting needs. They are the source of our food and we use them for irrigation and production of hydroelectric power. The biotic community of these water systems, both animals and plants are intimately integral associates. Alterations of their relationship depend on changes in the physico-chemical properties of environment. Thus there exists a dynamic and delicate balance. Often new water bodies i.e. reservoirs are also borne due to construction of dams on rivers.

Some others i.e. lakes, ponds etc. are slowly decreasing as they have to bear the brunt of municipal wastes, industrial effluents and city sewage. These toxic materials also induce deterimental alterations in the eco-physiology, which change the physiological status of the organisms living in water bodies and reflects the condition of environment too. Some of them accumulate the toxic substances i.e. heavy metals and biocides which cause the adverse effects on metabolic activities and may even be fatal due to borne diseases.

Water pollution takes place when effluents from factories, paper mills, sugar mills, tanneries etc. are let into rivers. These effluents also seep through and pollute under-ground water too. Effluents from large number of tanneries in North Arcot District in Tamil Nadu, have polluted well in water in large number of villages.

The most widespread source of water pollution is disposal of sewage of urban centers into rivers. Sewage contains approximately 300 mg/L. of dissolved solids in excess of the level of water supply (Ministry of Technology 1965).

It will therefore be seen that the passage of river near a large population centre considerably effect the mineral content of the river water (Tebbutt 1965).

Pollutants may also have potential effect upon human health by drinking such water, which is especially on people who live in vicinity of such environment. The presence of potential human health hazards from persistent bioaccumulative chemicals may be more readily detected by analysis of aquatic organisms than by analysis water samples (NCRT 1984).

Water pollution is the man made adverse changes in the ecosphere. But, if it can be and has to be maintained and reduced to the minimum, so that ecological balance could be maintained by taking various precautions which is necessary for the healthy survival of all living beings.

Aquatic animals are good markers to gauge the extent of water pollution. No rivers is in a satisfactory condition unless fish live and thrive in it. With regards to the fisheries of the rivers, the ecology of the surface run-off, water plays the most important role. Since ecology determines the habitability and abundance of flora and fauna in different sections (Mishra and Saksena, 1992). Hora (1942) was first to realize that the pollution in streams is likely to affect fishes. Verma and Dalela (1975) have studied fish

fauna of stressed rivers and have tried to designate fish species tolereant to pollution.

In India, a few studies have been made on the effect of pollution of natural waters on the occurrence of fishes (Bhimachar and David, 1946; Banerjee et. al., 1950; Motwani et. al., 1956; Banrejee and Motwani, 1960; Qasim and Siddique, 1960; Saleem, 1963; Tondon and Dhawan, 1967; Toor and Gill, 1974; Hussain, 1976; Das and Pande, 1982; Duda, 1982; Sehgal, 1984). A significant reduction in the growth and fecundity of the fishes inhabiting waters subjected to the sewage pollution has also been reported (Rajkumar et. al., 1984).

The pollution of river water has received our attention on recent years only which beyond self purifying capacity has caused human health hazards viz-typhoid and paratyphoid fevers, dysentery and cholera etc. and also adversely affected the aquatic fauna and flora. The Niagara river is one of the most chemically contaminated bodies of water in North-America. High levels of contaminants have been documented in the sediments of the Niagara rivers and eastern Lake Erie area near Buffalo, New York (Black et. al., 1989; Hang and Salvo, 1981; NRTC, 1984).

The Ganga, Yamuna and Ken etc. are polluted by municipal solid wastes, sewage disposal, leaching of pesticides and fertilizers which are used in agricultural crops. These rivers also provide domestic water supply. It is actually polluted water which causes various health hazards.

Rivers being dynamic systems are subjected to physical, chemical and biological variations due to diverse human activities. Urbanisation.

agricultural and pilgrimage activities cause an increase of nutrients in the water resulting increased productivity and increase of nutrients in the water resulting increased productivity in the concentration of dissolved substances to such an extent, that the water become contaminated at times, (Grobler et. al., 1983, Bruwar et. al., 1935). Eutrophication which is enhanced by aquatic weeds and massive development of planktonic algae in some time is observed, especially in section of low flow, resulting in interference with treatment process and problems in distribution system.

In Uttar Pradesh, the main source of water are Ganga, Yamuma, Gomti, Ghaghara, Ken, Betwa, Paisuani and Mandakini etc. which are higly polluted by untreated industrial effluents, municipal solid wastes, sewage discharge from cities and towns and also by human activities alongwith cremation. Ken, Betwa, Tars, Giri, and Chambal are tributaries of Yamuna which join to it at different places. Yamuna is highly polluted at Delhi, Mathura, Agra, Kalpi and Allahabad.

The quality of water is usually determined by its physico-chemical and biological characteristics. It is well established fact that domestic sewage and industrial effluents into natural water result in change of water quality and cultural eutrophication (Shaw et. al., 1991). The other important sources of water pollution include mass bathing, disposal of dead bodies, rural waste matters, agricultural run-off and solid waste disposal(Tiwana, 1992).

The river Ken is a hilly river. It's origin from the Ahirgawan village on the north-west slopes of the kaimur hills of Vindhyan ranges in the

Jabalpur district of Madhya Pradesh at an elevation of about 550 meters above mean sea level. The Ken is an interstate river between Uttar Pradesh and Madhya Pradesh. The total length of the river from its origin to confluence with the river Yamuna is 427 Km., out of which 292 Km. lies in Madhya Pradesh 84 Km. in Uttar Pradesh and 51 Km. forms the common boundary between Uttar Pradesh and Madhya Pradesh. The river Ken confluences river Yamuna near Chilla town of Banda district in Uttar Pradesh at an elevation of about 95 Km. This river is the last tributary of Yamuna . The river Ken basin lies between the latitudes of $23^0$12' North and $25^0$54' North and the longitudes of $78^0$30' East and $80^0$36' East. The total catchment area of the basin is 28058 Sq, Km., out of which 24472 Sq. Km. lies in Madhya Pradesh and the remaining 3586 Sq. Km. in Uttar Pradesh.

The basin course areas are of Jabalpur, Sagar, Damooh, Panna, Satna, Chatarpur and Raisen districts of Madhya Pradesh, Hamirpur, Banda districts of Uttar Pradesh. It is bounded by Vindhyan range in the south, Betwa basin on west , free catchment of Yamuna below Ken on east and the riverKen, Betwa, Tars, Giri, and Chambal are tributaries of Yamuna which join to it at different places. Yamuna is highly polluted at Delhi, Mathura, Agra, Kalpi and Allahabad.

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The fish fauna of Ken river is characteristics in having both plain and hill stream fishes. Hill streams fishes comprise of Tor spp.; Barilius spp.; Noemachilus spp.; Glyptothorax spp.; Lapidocephalichthys spp.; Which are Tor-tor Tor punctitore, Barilius borila, Barilius bola, Noemachilus batia, Gara gotyla, Lepidocephlichthyes guntea etc. are found. The presence of these fishes has own special feature because of hilly origin and it is advantageous for research work which might be carried out on these hill stream fishes at plains and they are also of more nutritious food value.

To some extent the river Ken is polluted at some places viz-Banda city, village Kanwara. Alona Pailani, Khaptiha and Chilla town in Banda district, which are situated near the bank of this river. Pollution is caused due to discharge of Urban and rural sewage, municipal waste, detergents from washing clothes, un brunt dead bodies, solid wastes cattle and human activities along with cremation. The fast development in recent decades of agriculture put serious strain on the river due to use of chemicals, fertilizer-pesticides, insecticides and weedicides their run-off reach in the river due to which the water quality become degraded to some extent. Problems of pollution of the river water has not only surfaced but begun to assume severe dimensions in certain stretches of the long course of the river.

International Biological programme (I.B.P.News No. 1 & 2 1964-65) have suggested that special attention should be given to the fresh water bodies which could be used for fish production. Keeping in view the need for enviournmental protection. The Indian Parliament passed the waterAct.1974. which became effective from 23rd March 1974, . The

CBPCWP was constituted in Sept., 1974. This Act. was also amended in 1988.

Having in view the above information as regards the unsuitability of water for the fish production and drinking purpose. The various measures as regards irradication of weeds, various pollutants and soil erosion etc. are suggested to tone up the river Ken so that the maximum fish production as well as suitability of water for drinking purpose might be done.

The Ken and Betwa are isterstate river to be linked under an historic agreement in which the U.P. and M.P. Government signed a memorandum of understanding (MOV) on August 24. The project aims to enhance irrigation and potable water supplies in both states, at an estimated cost of over Rs. 4,000 crore. It invisages the diversion of surplus water in the Ken river basin to the water-deficient Betwa basin through the construction of a dam on the Ken near its source and a canal to transfer the water in Betwa. This link project will ensure irrigation and water supplies to chhatarpur, Tikamgarh, Panna, Raisen, and Vidisha districts of Madhya Pradesh and Hamirpur, Banda, Jhansi, district in Uttar Pradesh. However strident critics of the project, including high-profile rights activist Medha Patker and enviournmentalist Vandana Shiva condemn the scheme, calling it a recipe for ecological disaster and violence from those whom it will force from their homes. Over 8,500 farmers and Villages will be forced out of their homes in order only to build the dam, and an unknown number by the canal. "It's really about spending money" says Shiva of the Research foundation for science, Technology and Ecology that has carried out its own detailed study and is helping to organise grassroots opposition to the Ken-Betwa project.

Antidam activist patker, enviournmentalist Sandeep Pandey regional director of G.S.I. criticised the project, saying it will damage the ecosystems of both the rivers.

All the facts of above link project of Ken-Betwa rivers showed that it will be beneficial to some extent such as irrigation and drinking water supply but it has many drawbacks as it will adversely effect the entire ecology of the river Ken because the water quantity will be lesser which is already insufficient, besides the hill stream fishes which are significant in this river are of very much importance as regards research work and also in fish production will be checked further the entire fish fauna which is already affected due to less amount of water. Obviously the fish productivity, scarcity of water in Banda its ecology, a number of farmers' will be more affected due to decreased quality of water, further many sufferers will have to be rehabilated.

Therefore, such projects should be planned by including some environmentalists in the committee, so that the plan might be made without disturbing the ecology of the concerned area and having in view the welfare of the farmers too.

REVIEW OF LITREATURE

HISTORICAL RESUME

Our civilization is facing turning point in the form of enviournmental pollution. It is affected by various sources among which the urbanization, industrialization, sewage, drains, municipal wastes unburnt dead bodies and cremation which causes toxicity in the water and its adverse impact on aquatic fauna and drinking water for human beings and cattle too. The water quality is detected by its physico-chemical and biological analysis. The riddle of these enviournmental protection hold a place of prominence among the global problems.

More work on physico-chemical and biological factors has been done in foreign countries but our country legs behind in this field. Among the workers some particular contributions are mentioned here.

Day. F. (1873) reported on fresh water fishes and fisheries of India and in (1878) observed the fishes of India. Hooker, (1872-77) reported the flora of British India. Sedgwick (1889) and forel et. al.(1892) are very old workers on this field. Kojoid (1903) studied the pollution and purification in the Illionis river system. Kolkwitz et. al. (1909) classified the pollution of river on the basis of organisms. Forbes et. al. (1913-19) studied the biology of upper Illionis river. Shelford (1917) and Ellis (1913) Classified river water into zones of pollution and clear water. Allen (1920) studied the quantitative and statistical study of the plankton of Sanjoaquin river and its tributaries in and near Stockton, California. Theriault, et. al. (1932) analyzed D.O. in the presence of organic matter, hypochloride and sulphite wastes. Howard (1933) determined total dissolved solids in the water analysis. Juday

et. al. 1935) reported Co_2 and pH of lake water of north-eastern Wisconsin. Majeed(1935) studied the fresh water algae of Punjab. Skuortzov (1935) studied the Diatoms from Calcutta India.

Biswas (1936) observed the common diatoms of the Loktak lake, Manipur. Ellis (1937) pointed out the breathing distress in fish resulted from clogging of the gills due to precipited mucus in addition to direct damage caused by organic matter. Ohle (1938) studied the control of liming in ponds for pH and alkalinity determination. Welch (1948) wrote Limnological methods, London.

Adyar is the first river in India which was explored hydrobio-logically by Chacko and Ganapati (1949). Ganapati et. al. (1950) reported the pollutional effect of the effluents of mettur chemicals and Industrial corporation Ltd. on the fishes of river Cauvery. Diehl et.al. (1950) studied the water hardness was understood to be a measure of the capacity of water to precipitate soap. The effect of Godavari had been shown by Ganapati and Chacko (1951) Welch (1952) wrote Limnology McGraw Hill Book company New York USA. John (1952) studied the effect of water pollution and its effect on public health. He also stated that enormous amount of untreated wastes have placed a great burden of pollution on over stream. Patrick (1953) studied the biological phases of stream pollution. Hildbrand (1953) studied that the concentration of sulphate in the most fresh waters is low. Sawyer (1953) observed that the ammonia is naturally present in surface and waste water. Ray, H.K. (1955) made a study of plankton ecology of the river Hooghly at Palta. Anderson, G.C. (1955) noted on the Phytoplankton and Zooplankton relationship in two lakes in Washington.

Kolthuff et. al. (1958) studied that pH determination helps in ascertaining the nature of water.

Chakrabarty et.al. (1959) made a qualitative study of plankton and physico-chemical condition of river Yamuna at Allahabad. Hynes, H.B.N. (1960) analysed the biology of polluted water. Rao (1961) carried out a systematic hydrogeological study in parts of Hoshangabad and Narsinghpur district of M.P. This revealed that the quality of water in this area was mildly alkaline. Gandhi, H.P. (1962) wrote a notes on the diatomaceae from Ahemadabad and its environs. International, water supply Association (1962) presented reports by Technical Commission on Pollution of surface water. Lovett, M. (1964) analysed the quality of river water as a factor in the determination of minimum acceptable flow. Arrora et. al. (1965) analysed biological characteristics of water quality at Nagpur. Qasim and George et. al. (1966) stated that Bajora river at Bareilly and Kali river near Merrut and Ganga river at Kanpur are contaminated with highly oxidisable organic components of Industrial waste which causes harmful effects. David and Ray (1966) observed that the wastes of about hundred tanneries, twenty textiles, woolen, cotton and jute mills with a number of chemicals and pharmaceuticals together with the four millions peoples wastes is also being added at Kanpur which make water toxic. Gopala Krishnan et. al. (1966) drew attraction that the effluents of fertilizers corporation of India in the river Damodar and of Sindri fertilizers showing its influence on the fish mortality of Panchat reservoir at Siwan distt. in North Bihar.

Bulusu et. al. (1967), Studied the various parameters i.e. D.O., B.O.D. pH etc. of Khan river which confluences with Kshipra river and effects it.

Hutchinson, G.E. (1967) wrote on a treatise on limnology. Srivastava , G.J. (1968) observed the fishes of the Eastern Uttar Pradesh. Malhotra, Shetty and Ghosh (1968) presented the papers on production of the quality of fish seed for fish culture at Barrackpore. Banerjea (1969) described the east-west river system as tributary of Mahanadi, faces severe pollution problems due to the discharge of many paper mills. Foged, N. (1971) observed the fresh water diatoms in Srilanka. Gopal Krishnan et. al. (1973), Ghosh et. al. (1973) described the multifarious industrial wastes on Hoogly in west Bengal. Chakaraberty et. al. (1974) observed at Yamuna that the decrease of O_2 consumption was mainly due to reduce efficiency of gills in fishes. Jhingran (1974) described the Kali river and its effluents of petroleum industry where D.D.T. and atomic energy establishment wastes have been worked up. Venkateswaralu, V. (1976) studied the Taxonomy and Ecology of algae in river Massi Hyderabad Dutta and Gupta (1976) analysed some experiments on aquatic weeds control in fisheries lakes and streams in U.P.. Sahai and Sinha (1976) studied the productivity of submerged macrophytes in polluted and non polluted regions of the Eutrophic lake at Ramgarh. U.P.Vass, et. al. (1977) studied hydrobiological conditions of river Jhelum and found annual variation of water. Bates (1978) studied that the pH is used in alkalinity, Co_2 measurement and many other acid base equilibrium. Hautage (1978) studied the pollution of Naha river in Germany and its tributaries, which showed high pollution level at certain points due to pouring of domestic and industrial wastes into it.

Govindan and Sunderesen (1979) studied the highly polluted nature of scum oil organisms in Adyar river of Madras. Train (1979) described the

various parameters of waste water criteria and said alkalinity is important for fish and other aquatic life.

Crayton and Sommerfeld (1979) observed the composition and abundance of phytoplankton in tributaries of the lower Colorado river. Kant Shashi (1979) made a study on diatom as indicator of water quality. Gupta (1979) observed Icthyofauna of the river Paisuni, Banda. Pande et. al. (1980) studied the metallic contents in water and sediments of lake Nainital. Sinha et. al. (1981) studied waste load allocation and general river water quality status industrification. Badoda and Singh (1982) analysed the hydrobiologyof the river Alaknanda of the Garhwal Himalaya. Mitra (1982) studied that the chemical characteristics of surface water at a selected gauging station in the river Godavari, Krishna and Tungabhadra and concluded alkalinity, Cl, Na, K. etc. are high. Upadhayay et. al. (1982) studied the physico-chemical conditions of the river of Kathnandu valley and reported pH, temp; and conductivity.

Singh (1983) studied hydrobiology of a pond in Shajahan garden, Agra, Bhargava (1983) investigated the quality of river Jamuna and concluded that the water of the river is good enough to human consumption only after suitable treatment, Verma, Sharma et. al. (1984) studied the pollution and saprobic status of Eastern Kali nadi Raina et. al. (1984) studied the physico-chemical quality of river Jhelum. Nautiyal (1985) studied the reverine ecology of Torrential water in uplands of the Garhwal region and seasonal variations in percentage occurrence of Planktonic algae. Patil and Gouder (1985) studied the ecology of fresh water Zooplankton of a

subtropical pond Karnataka. Handa et. al. (1985) studied Cu, Pb, Mn. and Zn in various unfiltered steam water samples of U.P. Adholia (1986) studied.

The hydrobiology of river Betwa and analysed temperature and pH. Hasan et. al. (1986) studied the levels of some heavy metals in river water, well water and consumer water supplies river sediments in Calcutta, Delhi, Kanpur, Lucknow and Nagpur cities. Joshi (1986,1987) reported about the presence of some pesticides like B.H.C., D.D.T. Endosulfan, Dimethuate and methylparathin in sediments and water samples in Bhagirathi-Hoogly stretch of Ganga river system.

Lakshman et. al. (1986) examined the quality of water supplied in and around the twin cities of Hyderabad and Secunderabad with respect to pH, Chloride which are permissible for drinking water. Bird (1987) studied the effects of hydrobiological factors on the concentrations of copper, iron, mangnese and zinc, in river Tawa in south wales, which cause errosion and weathering. Dora et. al. (1987) investigationd water quality of Subenrakha in Bihar state and reported Cu, Zn. due to disposal of waste water. Rao et. al. (1987) studied some selected rivers of India and observed that river water quality tends to be influenced by the existence to Industrialization and urbanization, discharge of toxic wastes which deteriorate the quality of natural streams. Mathura et. al. (1988) assessed heavy metal pollution and D.O. levels in river Ganga in Varansi region. Palharya et. al. (1988) studied the pollution of Narmada river at Hosangabad and registered pH D.O., Cl and B.O.D.. Sengupta et. al. (1988) studied the level of pollution of Ganga river.

Kulsherstha et. al. (1989) determined the heavy metal contents in river Khan, Kshipra and chambal of M.P. and Rajathan. Viel et. al. (1989) studied the water quality of surgon river of Vietnam which is the main source of drinking water in Hochi-Minch city. CBPCWP (1989) observed that the industries of Bombay 13% of total wastes dumped into water bodies, in Calcutta 89% of wastes are domestic origin and in Delhi the Yamuna takes in every day about 200 million litres of untreated human wastes while the industries account for only 20 million litres of effluents. Bharti et. al. (1990) studied the effect of industrial effluents on river Kali around Dandeli at Karnataka. Malviya (1990) observed on Ecological impact of sewage and effluents disposal in river Narmada at Hosangabad. Mittal et. al. (1990) analysed the physico-chemical characteristics of water Karwan river , Agra. Singh et. al. (1990) studied the water quality of Subernarekha river industrial belt on Ranchi.

Taylor et. al. (1990) analysed the quantitative analysis of dissolvedtrace metals on the Mississippi river at United states. Tripathi et. al. (1990) studied the water pollution of river Narmada at different points and reported temperature, D.O., B.O.D., C.O.D. fleuctuated. Varughese (1991) examined the hydrobiological status of river Narmada with special reference to phytoplankton and periphyton from Amarkantak to Hosangabad. Jhingran (1992) studied the fish and fisheries of India. Rieneld et. al. (1992) suggested that river water quality can be improved by the management of non point source water pollution problems. They studied on Svarta river basin in south central Sweden. Verma et. al. (1992) studied an impact of industrial effluents on aquatic biota of river Subernarekha at Ghat Sila at three different stations.

Agrawal (1993) studied on physico-chemical and Biological characteristics of river Betwa from Nagapur to Vidisha. Gupta et. al. (1993) studied toxic contamination of metal in river Betwa, Tapti river pollution in M.P. and comparative study of pollution level of upper lake and kolar reserviour water, Bhopal. Ahmed, et. al. (1993) reported correlation between physico-chemical factors and Zooplankton in Dholi tank, Bihar. Rao et.al. (1993) discussed the seasonal variation in physico-chemical property of tropical high altitude lake. Verma (1993) analysed physico-chemical & Biological parameters of Betwa river at Mandideep.

Gupta et. al. (1994) studied the seasonal variations in selected limnological parameters in Amarchand reservoir Rajsthan. Dixit and Smol (1994) analysed that diatoms as indicator in the enviournmental monitoring and assessment of surface water. Ramana et. al. (1994) studied the water quality of river Tungabhadra. Choubey (1995) studied water chemistry of Tawa river and reservoir in central India. Singh (1995) analysed the physico-chemical and biological analysis of river Ganga in Kanpur district. Ramgothaman et. al. (1995) studied the hydrobiology of Tapti river fromJhelum region. Ramgothaman et. al. (1995) observed the physico-chemical parameters of Narmada estuary. Shrikanth et. al. (1995) studied physico-chemical parameters of river Pennar, Andhara Pradesh. Shivasubramani et. al. (1995) analysed physico-chemical parameters of the upstream and down stream of the Periyar river and found average pH ranged from 6.7 to 7.00.

Venkata et. al. (1995) studied the water quality of Tirupati river and reported pH, D.O. , B.O.D., and hardness. Verma et. al. (1995) studied physico-chemical characteristics of fresh water pond at Laxmisagar. Antoine et. al. (1996) analysed the enviournmental and hydrological characteristics of the river Taff, South wales, U.K. Lal (1996) observed the effects of mass bathing on water quality of Pushkar Sarovar. Shukla (1996) compared the physico-chemical characteristics of water quality of river Betwa, Kolar dam and upper lake of Bhopal. Singh et. al. (1997) estimated the concentration of trace metals and some physico-chemical characteristics of river Beas in Himanchal Pradesh. Upadhyay (1997) studied physico-chemical analysis of Kaliasote dam water.

Doctor. et. al. (1998) observed the physico-chemical and microbial analysis of dye contaminated river water. Jain, et. al. (1998) investigated the effects of waste disposal on the water quality of river Kali with hazardous. Khurshide et. al. (1998) studied the effects of waste disposal on water quality in parts Cochin, Kerela. Sharma (1998) assessed the agriculture use of sewage water is favourable in Gwalior. Anjali (1998) studied on Zoo-phytoplankton in river Yamuna at Kitham. Nanda et. al. (1999) studied the effect of discharge of industrial effluents on the quality of river Brahmani at Rourkela. Pande et. al. (1999) analysed the distribution of organic matter and toxic metals in the sediments of Ramganga river at Moradabad. Sharma et. al. (1999) assessed the water quality of river Yamuna at Agra. Singh et. al. (1999) determined thephysico-chemical characteristics of water in the Damodar river. Xavier et. al. (1999) determined hydro-chemical characteristics of Chaliyar river.

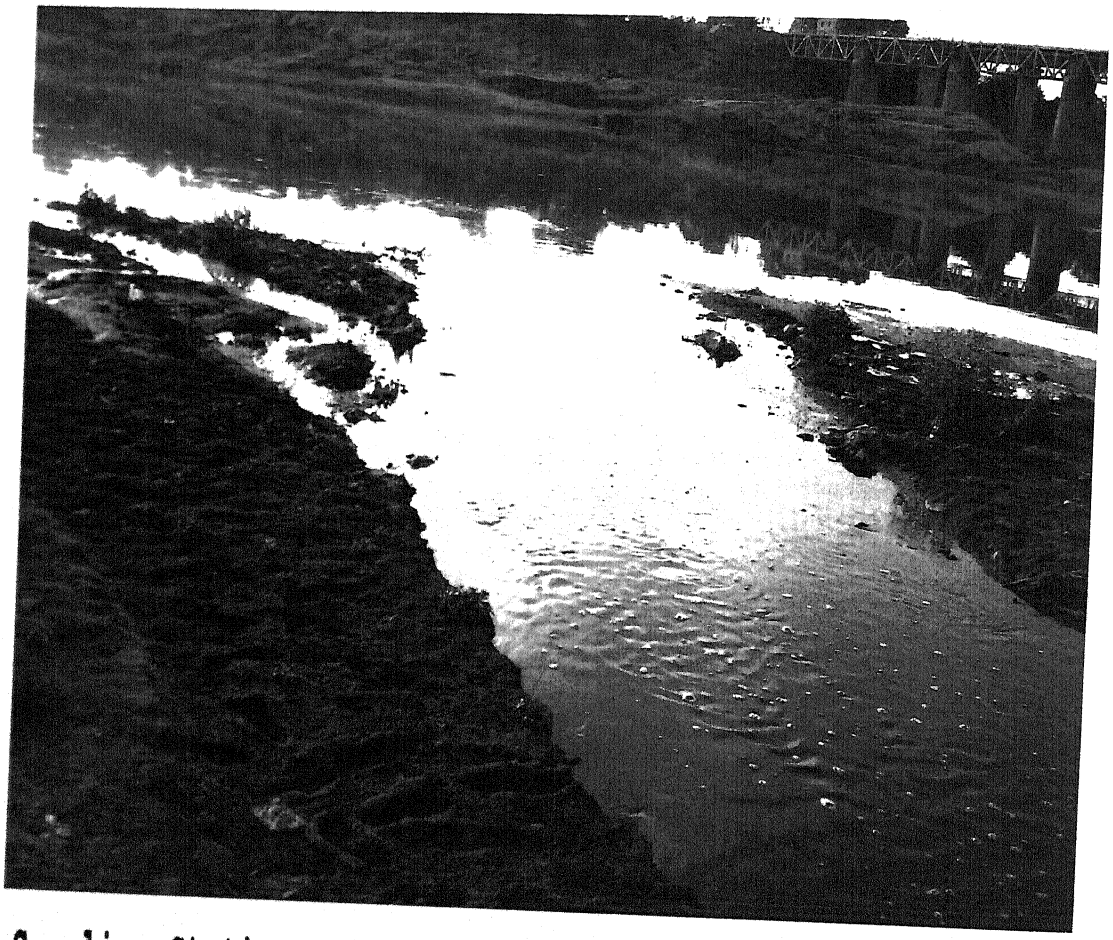
Singh (2000) studied the seasonal variation of Zooplankton in tropical lake. Azizul Islam et. al. (2001) studied the limnology of fish ponds in Rajshahi Bangladesh. Mishra et. al. (2001) observed the impact of city sewage discharge on physico-chemical characteristics of Ganga water. Bhasker Bhadra et. al. (2002) investigated physico-chemical and bacteriological investigations on the river Torsa of North Bengal. Saravanan et. al. (2002) studied the fresh water fishes as indicators of Kaveri river pollution. Kala Rakhee et. al. (2002) analysed the effect of physico-chemical factors on phytoplankton in lotic enviournment of Alaknanda river, Garhwal Himalaya.

Mishra et. al. (2003) studied the seasonal variation in physico-chemical characteristics of Ganga water as influenced by sewage discharge.

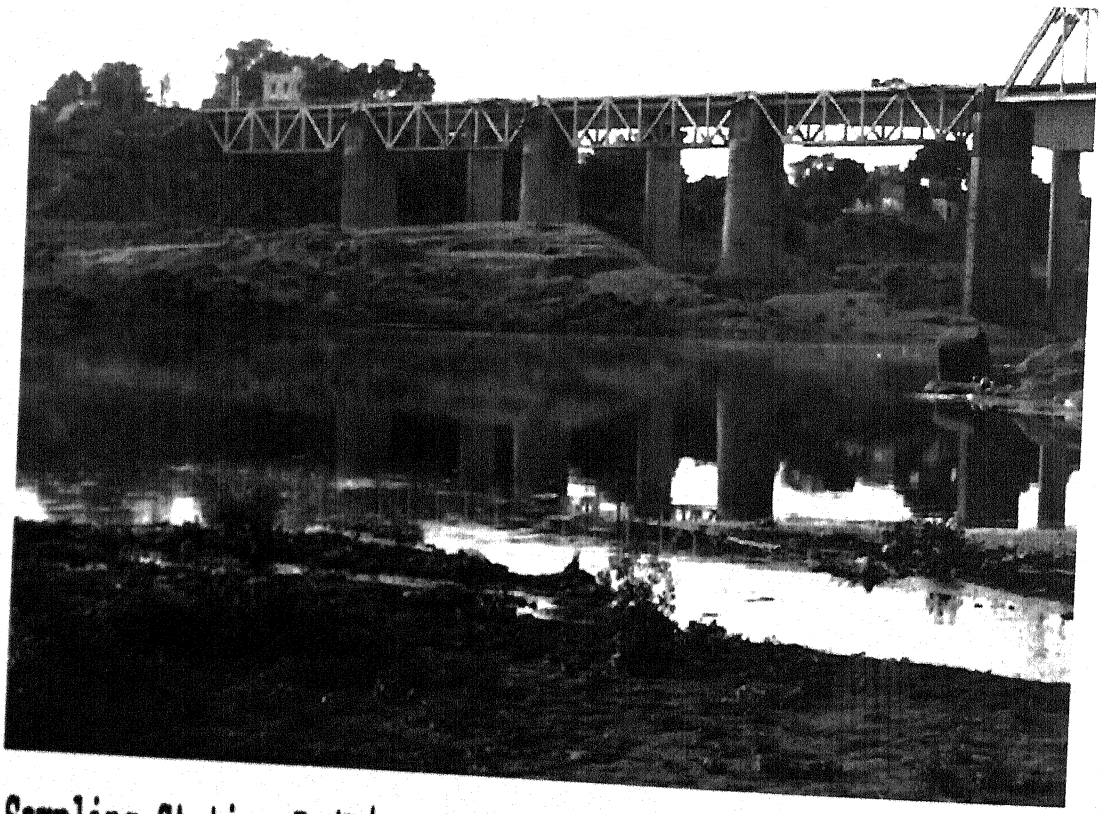
Iqbal (2004) studied the hydrobiological studies on river Nakatia at Bareilly. Dubey et. al. (2004) investigated ecological restoration and sustainable development problems and their perspectives. Kyessi (2005) studied the community based urban water managment in fringe neighbourhoods. Alegre et. al. (2005) observed the performance indicators for water supply services. Imura et. al. (2005) studied the Japan's enviournmental policy.

All these studies evidently showed that the effect of all the pollution sources on river water is severe and these lotic components need to be hydrobiologically monitored.

METHODOLOGY



Sampling Station I (Nala enter in to ken at Banda) Plate 1



Sampling Station I (U/S Near Railway Bridge at Banda) Plate 1

METHODOLOGY

Physico-chemical and biological parameters reflex the light on the assessment of water quality along with the measurements of pollution. An integrated study in the concern of fish productivity and quality of water for the suitability of drinking purpose was carried out on Ken river in Banda district of U.P. in various seasons for the period of twenty four months i.e. from Jan. 2002 to Dec.. 2003. five experimental stations were selected for the present study which are I, II, III, IV and V. These were selected having in view different conditions of this stretch of river.

Station-I

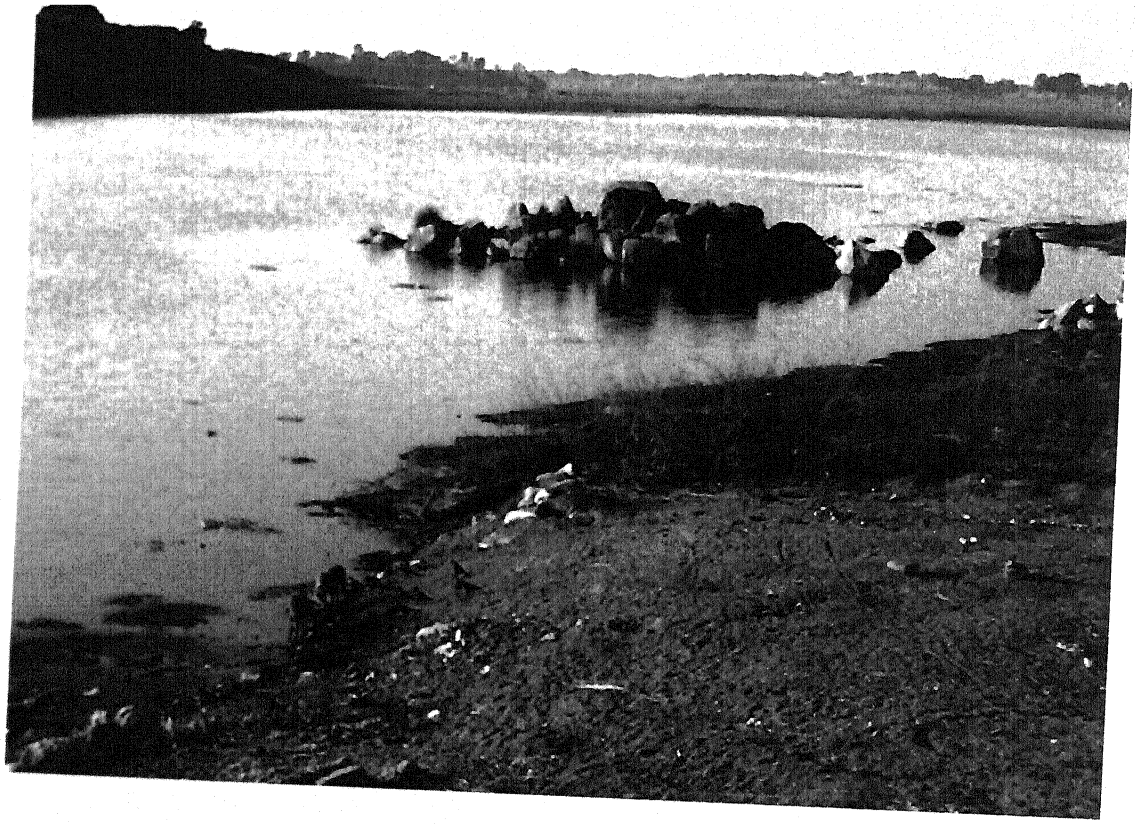
It is located on the eastern side near Banda city which is the upstream of the river fed by Ganda Nala of Banda city. (Plate I)

Station-II

It's location is also on the eastern side of the river in Banda city but is in down stream. This station is affected by washing, bathing and cremation activities. It is deeper than station I beside it is infested with thin aquatic vegetation. (Plate 2)

Station-III

It is located near village Khapatiha which is 16 Km. away from Banda city, here the washing, bathing and cattle activities aer quite enough besides the domestic sewage from this village is drained at this station through this Khapatiha Nala. Water flow is very slow here obviously aquatic weeds develop. (Plate 3)



Sampling Station II (D/S at cremation area in Banda city) Plate 2

Sampling Station III at Khapatiha) Plate 3

Station IV

It is located on the eastern side of the river near pailani town. A tributary of this river chandrawal confluences on western side of this river the western is being cultivated by growing various crops. (Plate 4)

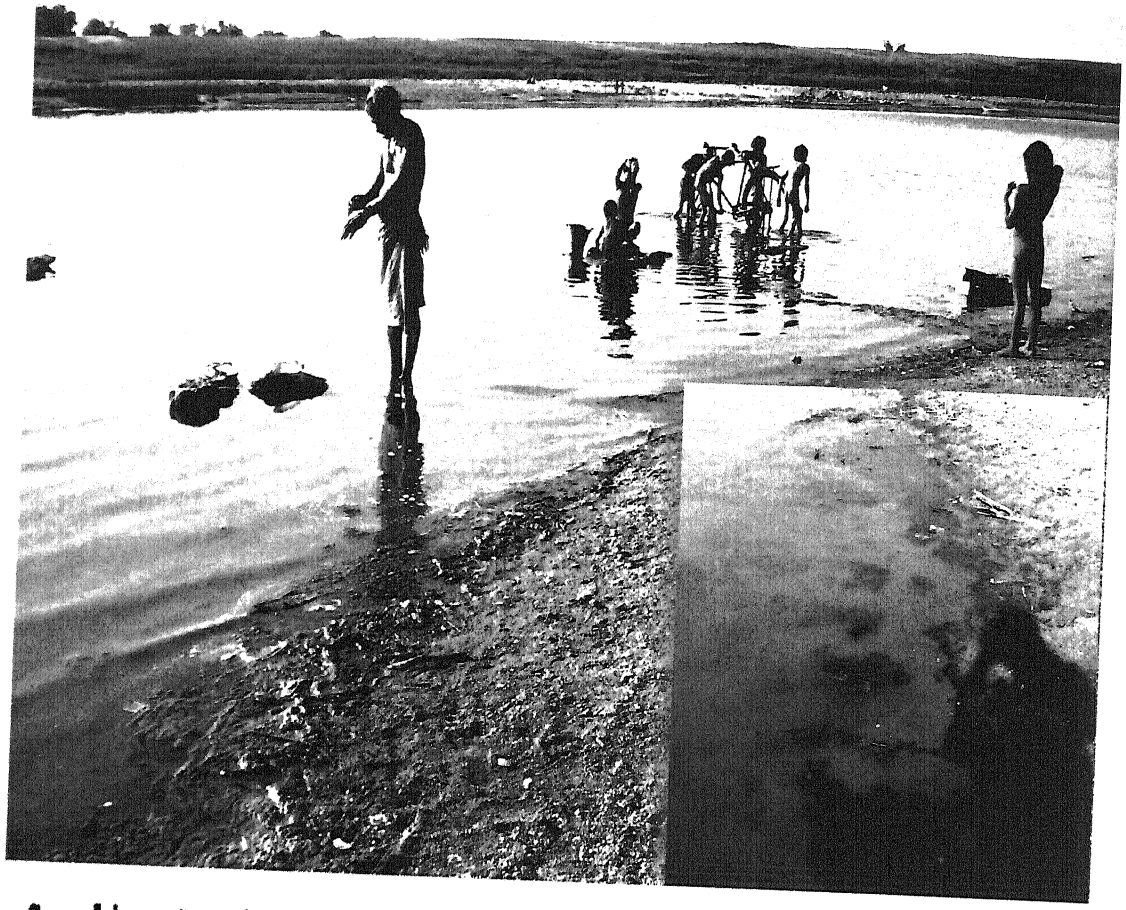
Station V

Near this station river Ken confluences with yamuna at Chilla Ghat, which is nearly 40 Km. away from Banda city. This is the deepest station where fishing is quite enough. (Plate 5)

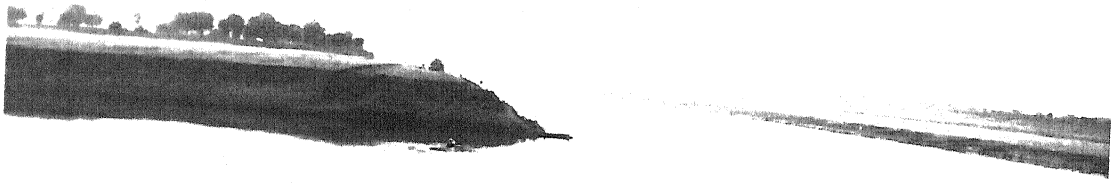
Physical investigation of all above five stations as regards water colour, light penetration were done visually where as water current and turbidity were measured cubic meter per second and Nephlometer respectively. Water temperature was measured by centigrade thermameter.

Collection of samples

For chemical and biological analysis of water samples were collected from all the above said five stations. The samples of water were collected in the Iodine treated polyethylene bottles with out much disturbance at the sampling stations of the river. The samples were collected in the first week of every month from Jan. 2002 to Dec.. 2003 in the early hours of the day with all the required precautions to avoid change in the chemical characteristics of water. Dissolved oxygen, Co_2, Total alkalinity, Total hardness, Chlorides, B.O.D., C.O.D. NH_4- N, Po_4, So_4 and pH were estimated in the laboratory within the period of 4 to 6 hours.



Sampling Station IV at Pailani town, Plate 4



Sampling Station V (Confluence into Yamuna at Chilla town) Plate 5

The planaktonic samples, aquatic weeds samples and bacteriological samples were also collected simultaneously.

The chemical Analysis samples were done as per methods of A.P.H.A. (1995) -

Hydrogen ion-concentration-(pH)

The pH of the samples was measured with lobibond pH comparator box at the sampling stations besides it was also confirmed in the laboratory by pH meter.

Total alkalinity (T.A.)

Total alkalinity was determined by titrimetric method, 50 ml. of the water sample was taken in a conical flask, placed on a white porcelein tile, two drops of methyl-orange indicator were added. This was titrated with O, O_2, NH_2SO_4 to a faint orange colour.

Reaction

$$HCO^-_3 + H^+H_2Co_3$$

Calculation

T.A. mg/l = (B x N x 50,000)/Vol. of sample (in ml.)

where,

B = ml. of sulphuric Acid

N = Normality of Acid used.

Total Hardness

It was determined titrimetrically using EDTA method (APHA 1995). 50 ml. of sample was taken in a conical flask, one ml. of Ammonia buffer

and a pinch of "Eriochrome black T" indicator was added and titrated against EDTA till colour changes from purple to bule.

Reaction

M^{++}EDTA (M.EDTA) complex

M^{++} Eriochrome Black TM. Eriochrome black T. (Wine red) complex.

Where,

$M^{++} = Ca^{++}$, and other divalent metal ions causing hardness.

Calculation

Total Hardness (mg/l) = A x 1000/vol. of samples (in ml.)

Where A = ml. of titrant used.

Chloride

The Chloride were determined by titrimetric method.

Reagent

(a) potassium–chromate solution :

Dissolved 5 mg. of potassium chromate in 100 ml. distilled water.

(b) Silver Nitrate (0.-2N) :

Dissolved 2.395 gm. of dried shilver nitrate (A.R.) in distilled water to make 1 litre of solution and kept in a dark bottle.

Procedure

50ml. of sample was taken in an Erlenmeyer flask to which 2 ml. of potassium chromate solution was added. The contents were then titrated against silver nitrate solution which gave a persistant reddish tinge to solution at the end point. Volume of silver nitrate required in reaching end point was noted. The chloride contents of sample were calculated as follows-

$$\text{Chloride mg./l.} = \frac{A \times N \times 1000 \times 35.5}{\text{ml of sample}}$$

where –

A = ml of silver nitrate used

N = Normality of silver nitrate solution.

Dissolved oxygen

(D.O.) The D.O. was determined by azide modification of wrinkle's method:

Reagents

(a) **Manganous sulphate solution:** Dissolved 100 gram of manganous sulphate in 200 ml. of boiled distilled water and filtered.

(b) **Alkali iodide azide solution:** (I) Dissolve 500 gm. of potassium hydroxide and 150 gm. of potassium iodide in distilled water to make 1 litre of solution.

(II) Dissolved of sodium azide in 40 ml. of distilled water. Mixed the two sodium I and II.

(c) **Sulphuric Acid :** Conc. H_2So_4 (Specific gravity .84) was taken.

(d) **Sodiumthiosulphate (0.025 N) Solution :** Dissolved 24.82gm. of sodium thiosulphate in boiled distilled water and made up the volume to one litre. Added 0.4 gm. of sodium thiosulphate in

boiled distilled water and made up the volume to one litre. Added 0.4 gm. of boreax as a stabilizer. This is 0.1 N stock solution.

Diluted it to four times with boiled distilled water to prepare 0.025 N solution (250 ml.- 1000ml.) kept in a brown glass stoppered bottle.

(e) **Starch Solution** :- Dissolved 1 gm. of starch in 100 ml. of warm (80^0c- 90^0c) distilled water and a few drops of formaldehyde solution for preservation.

Procedure

300 ml. of sample was drawn in a BOD bottle without air bubbles and to this were added 2 ml. of manganous sulphate solution and 2ml. of alkali iodide azide solution. The solution was mixed throughly and after 15 minutes 2ml. of concentrated sulphuric Acid was added to dissolved the precipitate by various shaking. 50 ml. of solution as indicator. The volume of titrant used in getting the end point (colourless) was noted. D.O. was calculated by the following formulas :-

$$\text{D.O. mg./l.} = \frac{\text{ml x N x 8 x 1000}}{V_2\,[(V_2-V_1)/V]}$$

where –

N = Normality of sodiumthiosulphate solution.
V_1= Volume of sample Bottle after placing the stopper.
V_2= Volume of the contents titrated.
V = Volume of manganous sulphate and potassium iodide added.

Carbon-di-oxide (Co_2)

The Co_2 was determined by phenolphthalein indicator method :-

Reagents

(a) **Phenophthalien Indicator-** Dissolved 0.5gm. of phenophathalein in 50 ml. of 95% ethanol and added 50ml. of distilled water. Added 0.05 N Co_2 free sodium hydroxide solution dropwise, till solution turned faintly pink.

(b) **Sodium hydroxide (0.05 N) Solution–** Prepared 1.0 N sodium hydroxide by dissolved 40gm. of sodium hydroxide in Co_2 free distilled water (boiled) to make 1 litre solution. Diluted 50ml. of 1.0 N sodium hydroxide to 1 litre. Standardized it with sulphuric acid.

Procedure

50 ml. of water sample was taken in a conical flask and added few drops of phenolphthalein indicator. It the solution turns pink then free Co_2 is absent. It which indicated presence of free Co_2 this was the solution remains colourless titrated against sodium hydroxide solution. The pink colour appeared at the end point. Volume of sodium hydroxide at this point was noted.

The free Co_2 was calculated as follows –

$$\text{Free } Co_2 \text{ mg/l} = \frac{A \times N \times 1000 \times 44}{\text{ml. of sample}}$$

where

A = ml .of sodium hydroxide solution.

N = Normality of sodium hydroxide solution.

Biochemical Oxygen Demand (B.O.D.)

Biochemical oxygen demand gives an idea about the extent of pollution. B.O.D. was estimated by incubation the sample in B.O.D. incubator was kept at 20^0 c and after 5 days D.O. was fixed which was estimated. Difference of initial D_0 (D zero) and final D_5 (D five) gave the total B.O.D.

Calculation – B.O.D. in mg/l = D_0- D_5 / V

Where –

D_0 = Initial dissolved oxygen.

D_5 = D.O. Calculated after 5 days.

V = Decimal volumetric fraction of sample used.

Chemical Oxygen Demand (C.O.D.)

C.O.D. was determined by potassiumdichromate Reflex method (NEERI, 1986). 20ml. of sample water was taken in a 200 ml. flask. The 10 ml. of 0.25 N potassium dichromate, 30 ml. of conc. sulphuric acid. A pinch of silver sulphate and mercuric sulphate were added and refluxed for two hours in a water bath. After two hours distilled water was added to make its volume 140 ml. 2 to 3 drops of ferrous indicator was added to refluxed sample, mixed thoroughly and treated with 0.25 N ferrous Ammonium sulphate till a brick red colour is obtained which is the end point. A blank was done with distilled water.

Calculation

C.O.D. in mg./l. = (A-B) x N x 8000 / volume of sample (ml)

Where A = ml. of titrant used with sample.

B = ml. of titrant used with blank.

N = Normality of $FeSo_4$ $(NH_4)_2$ So_4 . 6 H_2o

Ammonical Nitrogen (NH_4-N)

Direct Nesslerization method was adopted for this parameter. 50ml. of sample was taken, 5 drops of Rochelle salt solution and 2 ml. of nessler's reagent was added. After 10 minutes intensity of colour was measured on spectrophotometer at 420 nm wave-length. Value of NH_4-N was obtained from standard curve.

Phosphate (Po_4)

The phosphate content in water was intimated by stannous chloride method.

Reagents

(a) **Ammonium molybdate solution** – Dissolved 25.0gm. of ammonium molybdate in 175 ml. of distilled water. Added 280 ml. of concentrated sulphuric acid to 40 ml. of distilled water and cooled mixed the two solutions and dilute to1 litre.

(b) **Stannous chloride solution-** Dissolved 2.5 gm. of stannous chloride in 100 ml. of glycerol by heating on a water bath for rapid dissolution.

(c) **Phenolphathalein solution-** Dissolved 0.5gm. of phenolphthalein in 50 ml. of 95% ethanol and added 50ml. of distilled

water added 0.05 N Co_2 free sodium hydroxide solution dropwise, until the solution turned faintly pink.

(d) **Stock phosphate solution-** Dissolved 109.75 mg. anhydrous potassium di-hydrogen phosphate in distilled water. Diluted to 500 ml. (1 ml. =50 µ g phosphate)

(e) **Standard phosphate solution-** Taken 0.1 ml. of stock solution of phosphate solution and made up to 100 ml. with distilled water. (1 ml. = 50 µ g phosphate)

Procedure

50 ml. of filtered sample was taken in a tube to which 1 or 2 drops of phenolphthalein indicator was added to check carbonate alkalinity. If the sample turned to pink added strong acid solution drop wise to discharge the colour. Then added 2 ml. of ammonium molybdate solution and 0.25 ml. stannous chloride reagents and mixed thoroughly. After 10 minutes but before 12 minutes the blue colour was measured spectrophotometer at 690 nm. wave length.

The phosphate were found out with the help of standard curve and were calculated with the help of following formulas –

$$\text{Phosphate mg/l} = \frac{\mu \text{ gP} \times 1000}{\text{ml. of sample}}$$

Sulphate (So_4)

40 ml. water sample was taken into 100 ml. cylinders followed by 10 ml. Barium chloride solution. The sample was shaken and kept standing for 15 min. The reading of developed turbidity was measured on UV–V15 spectrophotometer at 420 nm. The concentration of sulphate was calculated by standard curve. Result were expressed in mg./litre.

Biological Factors (Phyto & Zooplankton)

Analysis technique

The phyto and Zooplankton were collected by means of plankton net (Welch 1948) and preserved in 4% formalin at the sampling site. The bolting silk No. 25 (65n) was used in the net. Which is attached with an iron ring of about 20cm. diameter in conical shape. The open tail side is about 2.3 cm. in diameter was tied firmly to a glass tube measuring 5 cm. in length and 2 cm. in diameter. In each collection 100 litre of surface water was collected by means of a jug , which was filtered through the plankton net. The filtrate thus contains planktons (Phyto & Zooplankton) 10 ml. of the filtered was preserved in 4% formalin at the spot. The quantitative and qualitative examinations were done in the laboratory by the standard methods (APHA 1995) and Goyal and Trivedi (1986). Before qualitative analysis each plankton sample was diluted and mixed with water to make it to 50 ml., 1 ml. of this sub sample was drawn quickly with a wide mouthed pipette and poured into a Sedgwick-Rafter plankton counting cell. All the organisms were identified up to genus level. Analysis of each genus was than calculated as No./litre of the water by the formula given by Welch's (1948).

$$n = (a \times 100).\ c / l$$

Where –

n = No. of plankton per litre.

a = Average No. of plankton in all count in a counting cell.

c = Volume of original concentrate expressed in litre.

l = Volume of Original water expressed in litre.

For the qualitative analysis the sample were examined under high power (10 x 100) of the microscope and identified by taking help of standard books and publications. (Turner, 1892; Smith, 1924; Prescott, 1962; Ward whipple, 1959; Phillipose, 1967; A.P.H.A., 1995; Goyal & Trivedi, 1986; Welch, 1948)

Total Coliform (MPN)

Water samples were collected separately for determination of Bacteriological analysis. Water samples collected in sterile sample bottles were transported to the laboratory in ice box and minimum elapsed time between collection and analysis in no case did exceed 30 hours. Bacteriological analysis consisted of standard plate count presumptive and confirmatory tests for coli form and MPN of total coli form.

Multiple tube technique was adopted for the estimation of the number of presumptive total coli form (MPN count) present in a given volume of water by inoculation of appropriate volume into a number of tubes of medium (Mc Conkey's broth) 10 ml. , 1.0 ml. of sample inoculated in the three sets of 5 test tubes, each containing 10.0 ml. of medium placed within 30 minutes all these tubes in incubator at 35 -37^{0}c.. After 43 hours each tube

was examined carefully. Those showing gas in the duraham's vial was recorded as positive (+).

$$\text{MPN/100ml.} = \frac{\text{No. of positive tube x 100}}{\sqrt{\text{Total sample (ml.) in Negative tube} \times \text{total sample in test}}}$$

Fishes

The fish were collected during night and also in early morning by Drag net and also with vertical nets (100' x 5') with a mesh (3' x 5') in diameter and they were identified with the help of Francis Day Fauna and also with Gopal Ji Srivsatawa for identification of fishes.

Aquatic Weeds

The sample of aquatic weeds were collected and their abundance was assessed by visual observations and identified up to Subramanyam (1962).

Meteorological data are recorded for the period of two years i.e. (2002-2003) from Collectrate Office at Banda and their means values were calculated.

OBSERVATION

OBSERVATION

The proper analysis of physico-chemical and biological factors of Ken river water have been studied for two years (from Jan;2002-Jan; 2003) for which monthly fluctuations with average values, standard deviation and co-efficient co-relation have been tabulated. As regards this the factors which were considered are:-

I . **_Physical factors-** water temperature, colour, turbidity, water current.

II . **_Chemical factors-** pH, D.O., B.O.D., C.O.D., Co_2, Cl, So_4, Po_4, NH_4-N.

III. **_Biological factors-** Phytoplankton, Zooplankton, M.P.N, aquatic weeds and economically important fishes. Meteorological conditions were also recorded.

Meteorological Conditions

These conditions are concerned with atmospheric temperature, rainfall, humidity and photoperiod, their monthly mean values have been recorded during the period of two years study. As regards these conditions the data are recorded as under:-

Atmospheric Temperature

During the investigation period from Jan.2002 to Dec.2002, it varied from 8.87 to 41.3^0c and in Jan.2003 to Dec.2003 ranged between was 6.3^0c to 41.45^0c. The lowest atmospheric temperature was recorded in the month of winter season (Jan.) in both the years whereas highest value was observed in the month of summer season (April) in first year and in the second year in the month of June. (table 1 & 2 fig 2 & 3) it was observed that atmospheric temperature

increases when the hours of the day increases.

Rainfall

In the first year (Jan.2002 to Dec.2002) it varied from 1.0m.m. to 248.32 m. m. and in second year (Jan.2003 to Dec.2003) it ranged between 3.0 m.m. to 134.60 m.m. Lowest rainfall was recorded in the month of Dec. and the highest was observed in August in both the years whereas in the months of Jan., March, Oct. and Nov, in the year of 2002 rainfall was nil and in the months of Jan, April, May, Oct, & Nov, in the year of 2003 rainfall was also nil (table 1 & 2, fig 2 & 3). It was noticed that highest rainfall depend upon monsoon.

Relative Humidity

It varied from 20.10% to 81.16% during 2002 and in 2003 ranged between16.17% to 79.13%. The lowest humidity was recorded in June while the highest was observed in August in both the years (table 1&2, fig 2&3). It is effected by rainfall and atmospheric temperature.

Photoperiod

It varied between 10.16 hrs. and 13.34 hrs. in 2002 and in 2003 ranged between 10.07 hrs. to 13.20 hrs. Lowest photoperiod was recorded in Jan. while the highest was observed in June in both the years (table 1&2, fig 2&3).

I-Physical factors

In the present study water temperature, turbidity, water current and colour were observed:-

Water Temperature-

The water temp varied from 17.00^0c to 31.32^0c in 2002 and between 14.00^0c to 31.28^0c in the year 2003 at five sampling stations.

The lowest temperature of water was recorded in winter months i.e. Dec. and January in 2002 and 2003 respectively while the highest value was recorded in summer months i.e. may and June in 2002 and 2003 respectively. It is directly effected by atmospheric temperature.

Turbidity-

It varied from 24.00 to 77.00 N.T.U. in 2002 and 25.00 to 78.00 N.T.U. in 2003. Maximum turbidity was observed in the month of August while the minimum average value was observed in the month of Dec. in both the years. The higher trend of turbidity was observed during monsoon and summer season due to silting and decomposition of organic wastes and run-off.

Water Current-

It varied from 5.3 to 1000.9 cu.m./second in 2002 and 2003 at all sampling stations. Lowest water current was recorded in summer i.e. June month, whereas highest value was recorded in rainy season i.e. August & September. It's highest value was notice in the monsoon period due to high rainfall.

Colour-

The colour of water was found to vary from—muddy, greenish and transparent . Muddy colour of the water observed in the month of July and August, greenish colour of the water noticed in the month of September, October, May and June whereas transparent colour was found in the month of November, December, January,

February, March and April in both the years. Colour of the water depend on growth of Phytoplankton, Algae and Turbidity.

Light Penetration-

The light penetration was found to vary from high to low. In month of May, June, July and Oct. was high and in Jan. Dec. Aug and Sept. the low penetration of light was found, while the medium light penetration in the months of Feb., Mar., April, & Nov. in both the years was found.

II- Chemical Factors

These include $_{p}H$, T.A., T.H., Cl, D.O., B.O.D., C.O.D., Co_2, Po_4, So_4, & NH_4-N, which are taken in the present study to analyse the chemical nature of the Ken river water.

Hydrogen ion Concentration (pH)-

In the present study The pH of river water was observed between 7.50 to 8.20 in the year of 2002 and in 2003 it ranged between 7.49 to 8.19. The lowest pH of was observed in the month of Dec. while highest value was noticed in the month of June in both the years. This water was found alkaline throughout the period of study. It was observed that the Co_2 concentration affects pH of water.

Total Alkalinity(T.A.)-

During the present study period the value of alkalinity varied from 120 to 172 ppm in 2002. whereas in 2003 it ranged between 120 to 173 ppm. Maximum average value was recorded in the month of June and minimum value was found in January in both the years of

study. It was noticed that total alkalinity depend upon pH and hardness of water.(Table —fig—).

Total Hardness(T.H.)-

During the study period of 2002 it ranged between 80 to 162.00 ppm and in 2003 varied 82.00 to 162.00 ppm. The maximum average of this factor was found in month of June while minimum value recorded in the month of August during the entire period of study. It particularly reveals the nature of water of the river. It was seen that it is directly affected by alkalinity of river water.

Chloride(Cl) –

Importent study ranged of fluctuation was 49.00 to 14.00 ppm. in 2002 and in 2003 recorded between 49.00 to 12.00 ppm. maximum average value was recorded in the month of may while minimum value was recorded in the month of August in both the years of study. High concentration of chloride indicates pollution which is caused by decomposition of organic wastes of animals.

Dissolved Oxygen(D.O.) –

In the study period it was found 8.93 ppm. to 6.74 ppm. in 2002 and in 2003 ranged between 8.93 to 6.76 ppm. maximum value was found in the month of Jan. while minimum ranged was in the month of July in both the years. It was found that D.O. concentration was effected by the concentration of animal excreta.

Carbon dioxide (Co_2) –

In the first year 2002 it ranged between 4.6 to 1.6 ppm. and the second year 2003 4.7 to 1.5 ppm. maximum average value was recorded in the month of June while minimum in January. It was observed that Co_2 adversely effects D.O.

Biochemical Oxygen Demand (B.O.D.)-

In the study period it varied from 2.50 to 1.10 ppm. in 2002, and in 2003 it ranged between 2.40 to 1.00 ppm. The maximum value was found in month of June whereas minimum value was recorded in the month of September during entire study span. It determines the strength of pollution of sewage in water. It is the amount of oxygen required to degrade the organic and chemical wastes until the water again purified. It is observed that B.O.D. is directly related with chloride and C.O.D.

Chemical Oxygen Demand (C.O.D)-

In the present investigation in river water C.O.D. value varied between 14.00 to 6.30 ppm. The minimum value 6.30 ppm. was observed in the month of August 2003 and the maximum value 14.00 ppm. was also found in the year of 2003. It is observed that C.O.D. is always greater than B.O.D. values. A direct relationship was observed between B.O.D. and C.O.D. Toxicity of water was found responsible for these factors. The C.O.D. test is helpful in indicating toxic condition and the presence of biologically resistant organic substances.

Phosphate (Po_4)-

It is observed that considerable irregular increases in the concentration of phosphate indicates the presence of pollutants. In present findings the concentration of river water was found in the range of 0.17 to 0.56 ppm, in year 2002 and in 2003 varied from 0.17

to 0.57 ppm. The maximum average value was recorded in the month of August while minimum value was found in the month of December & January in both the years. It's higher concentration was found in rainy months which may be due to storm and run-off.

Sulphate (So_4) –

It's determination in polluted water is important because it is directly associated with odour and corrosion problems. In present study sulphate content was observed in the range of 1.74 to 4.53 ppm in 2002, while in 2003 it was found in the range of 1.65 to 4.67 ppm. The minimum concentration was found in September and maximum concentration was noticed in the month of June in both the years. It's concentration is effected by domestic sewage.

Ammonical Nitrogen (NH_4-N) –

In the present findings ammonical nitrogen varied between 0.01 to 0.12 ppm. in the first year (2002) while in the second year (2003) the range of ammonical nitrogen varied between 0.01 to 0.13 ppm. Maximum concentration was noticed in the month of June in both years whereas minimum concentration was found in August & January at station No. I & IV respectively in 2002 and in 2003 at station I. The increase trend was noticed in summer and post monsoon period. Sewage has large quantities of nitrogenous matter, which increases ammonia contents of the water and enhances Ammonical Nitrogen which showed pollution in water.

Total Colifrom (MPN) –

In the present investigation the total colifrom was observed in the range of 52 to 1606/100 ml. throught the study span. The MPN value varied from 55 to 1602/100 ml. in 2002 while in 2003 it ranged from 52

to 1606/100 ml. The minimum value of MPN was found in the month of January and maximum value noticed in the month of August during the period of study.

At all stations higher range of MPN was noticed during summer and monsoon season. It's range was found to be effected by organic matter decomposition in mansoon and summer season.

Table -1

Meteorological Data

Monthly Average Jan. 2002 - Dec. 2002						
Month	Atmospheric Temperature (0c)		Relative Humidity (%)		Monthly Rain Fall (mm)	Photo period (Hrs.)
	Maximum	Minimum	Morning	Evening		
January	23.87	8.87	32.18	25.16	Nil	10.16
February	28.54	12.57	40.21	27.58	9.80	11.10
March	34.84	17.66	30.16	22.13	Nil	11.04
April	41.30	23.35	38.81	26.18	7.00	12.45
May	40.58	28.30	33.99	22.34	3.90	13.30
June	39.76	28.96	32.96	20.21	3.80	13.34
July	38.08	28.50	46.68	29.10	25.47	13.25
August	32.51	25.06	81.16	68.06	248.32	12.56
September	31.33	24.21	54.56	32.16	66.31	11.51
October	32.90	20.61	46.66	20.10	Nil	11.00
November	27.54	15.05	44.31	27.56	Nil	10.45
December	24.09	10.95	32.22	24.21	1.00	10.25

Table -2

Meteorological Data

Monthly Average Jan. 2003 - Dec. 2003						
Month	Atmospheric Temperature (0c)		Relative Humidity (%)		Monthly Rain Fall (mm)	Photo period (Hrs.)
	Maximum	Minimum	Morning	Evening		
January	18.19	6.31	54.50	32.50	Nil	10.07
February	23.88	17.79	52.45	30.10	16.40	11.42
March	32.20	16.35	40.00	28.12	2.53	11.42
April	38.69	23.11	35.10	27.60	Nil	12.33
May	40.71	25.88	30.16	16.17	Nil	13.02
June	41.45	28.55	55.01	34.46	65.50	13.20
July	34.29	29.92	65.50	55.02	96.60	13.16
August	33.26	27.24	79.13	59.40	134.60	12.46
September	31.85	25.75	55.21	36.12	74.20	11.74
October	28.11	21.27	51.21	30.16	Nil	11.22
November	31.68	18.60	49.64	27.10	Nil	10.52
December	24.36	13.79	40.45	26.31	3.00	10.50

Table - 3

Physico-Chemical Characteristics of Ken River

Station -1 **Period : 2002**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D .ppm.	C.O.D. ppm.	NH_4 - N ppm.	Co_2 ppm.	Po_4 ppm.	So4 ppm.	MPN. Org/l
Jan.	18.00	30.00	Low	10.1	7.820	126.00	126.00	29	8.90	1.50	8.20	0.02	1.60	0.19	3.20	56.0
Feb.	20.00	38.00	Med	15.6	8.120	130.00	146.00	26	8.27	1.30	8.90	0.03	2.00	0.23	2.68	84.0
Mar.	23.00	40.00	"	20.4	8.150	135.00	120.00	30	8.03	1.60	10.20	0.05	2.70	0.20	2.60	110.0
Apr.	27.00	41.00	"	12.3	8.170	143.00	140.00	44	7.80	1.80	10.60	0.07	2.90	0.22	3.55	168.0
May.	29.29	60.00	High	8.8	8.190	145.00	130.00	49	7.72	2.00	11.90	0.07	3.70	0.38	3.81	170.0
Jun.	30.33	65.00	"	5.7	8.100	170.00	162.00	40	7.56	2.50	13.00	0.10	4.60	0.40	4.52	260.0
Jul.	28.10	69.00	"	400.6	8.010	130.00	95.00	38	6.74	2.20	10.30	0.04	3.60	0.42	2.12	900.0
Aug.	26.77	76.00	Low	1000.8	8.100	120.00	80.00	15	7.21	1.80	6.50	0.01	3.50	0.54	1.75	1600.0
Sep.	28.33	70.00	"	1000.5	8.200	124.00	93.00	26	7.73	1.10	8.70	0.03	3.00	0.39	2.00	240.0
Oct.	26.06	40.00	High	100.6	8.040	134.00	128.00	32	7.69	1.40	7.50	0.04	3.20	0.26	2.10	115.0
Nov.	22.06	30.00	Med	30.0	8.200	134.00	133.00	40	7.79	2.00	10.20	0.06	2.80	0.20	2.30	108.0
Dec.	17.29	25.00	Low	16.0	8.300	126.00	103.00	32	8.15	1.60	9.00	0.04	2.10	0.19	2.45	65.0

Table - 4

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station I — **Jan.2002 - Dec -2002**

	W.T. °c	Tur. N.T.U.	Water Current Cum./Se	p^H	T.A. ppm	T.H. ppm	Cl. Ppm	D.O. ppm	B.O.D. ppm	C.O.D. ppm	NH_4N ppm	Co_2 ppm	Po_4 ppm	So_4 ppm	MPN org./ l
W.T.	1.00														
Tur.	0.82	1.00													
Water Current	0.37	0.72	1.00												
p^H	0.08	-0.03	0.04	1.00											
T.A.	0.50	0.13	-0.49	0.08	1.00										
T.H.	0.00	-0.38	-0.77	-0.07	0.76	1.00									
Cl.	0.32	-0.14	-0.61	0.19	0.66	0.55	1.00								
D.O.	0.74	-0.74	-0.47	-0.18	-0.12	0.37	-0.11	1.00							
B.O.D.	0.45	0.30	-0.25	-0.01	0.67	0.28	0.56	-0.51	1.00						
C.O.D.	0.40	0.09	-0.50	0.25	0.84	0.60	0.82	-0.15	0.68	1.00					
NH_4N	0.45	0.02	-0.53	0.31	0.94	0.70	0.81	-0.16	0.67	0.92	1.00				
Co_2	0.21	0.75	0.22	0.14	0.64	0.08	0.33	-0.77	0.69	0.50	0.58	1.00			
Po_4	0.73	0.96	0.73	-0.04	0.05	-0.44	-0.21	-0.74	0.34	-0.03	-0.07	0.72	1.00		
So_4	0.24	-0.04	-0.59	-0.06	0.86	0.77	0.64	0.24	0.51	0.78	0.78	0.30	0.10	1.00	
MPN	0.37	0.70	0.71	-0.14	0.29	-0.64	-0.46	-0.68	0.28	-0.35	-0.38	0.41	0.81	-0.40	1.00

Statistical Values of Ken River

Station - 1

S.No.	Paramaeter	2002				2003				Total			
		Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
1	W.T.	24.69	4.29	30.33	17.29	24.32	5.70	31.27	14.19	24.50	5.00	30.80	15.74
2	Tur.	48.66	17.30	76.00	25.00	49.00	17.54	76.00	26.00	48.83	17.42	76.00	25.50
3	Water Current	218.45	365.46	1000.8	5.70	218.48	365.44	1000.9	5.80	218.46	365.45	1000.85	5.75
4	P^H	8.19	0.12	8.53	7.82	7.97	0.24	8.50	7.52	8.08	0.18	8.51	7.67
5	T.A.	134.25	12.74	170.00	120.0	137.16	14.58	169.00	121.0	135.70	13.66	165.50	120.50
6	T.H.	121.16	23.15	162.00	80.00	121.40	22.79	161.00	81.00	121.28	22.97	145.50	80.50
7	Cl.	33.41	8.88	49.00	15.00	33.75	8.78	48.00	16.00	33.58	8.83	48.50	15.50
8	D.O.	7.79	0.51	8.90	6.74	7.79	0.51	8.91	6.75	7.79	0.51	8.90	6.75
9	B.O.D.	1.73	0.38	2.50	1.10	1.73	0.41	2.40	1.00	1.73	0.40	2.45	1.05
10	C.O.D.	9.58	1.75	13.00	6.50	9.60	1.78	13.00	6.40	9.59	1.77	13.00	6.45
11	NH_4N	0.04	0.02	0.10	0.01	0.04	0.03	0.10	0.01	0.04	0.03	0.10	0.01
12	Co_2	2.97	0.80	4.60	1.60	2.99	0.81	4.60	1.50	2.98	0.81	4.60	1.55
13	po_4	0.12	0.11	0.54	0.19	0.14	0.11	0.53	0.19	0.13	0.11	0.23	0.06
14	So_4	2.75	0.81	4.52	2.00	2.76	0.80	4.54	1.74	2.75	0.81	4.53	1.87
15	MPN	323.0	442.94	1600	56.00	323.50	442.84	1600.0	55.00	323.25	442.89	1600.00	323.37

Table - 5

Physico-Chemical Characteristics of Ken River

Station - II **Period : 2002**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m /Sec	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D. ppm.	C.O.D. ppm.	NH_4 - N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	18.01	30.00	Med	10.2	7.76	121.0	127.0	30	8.90	1.50	8.30	0.02	1.7	0.19	3.21	57.0
Feb.	20.02	37.00	"	15.5	8.01	132.0	146.0	27	8.27	1.20	8.90	0.02	2.0	0.22	2.67	85.0
Mar.	23.02	39.00	"	20.3	8.02	134.0	121.0	31	8.03	1.70	10.30	0.04	2.0	0.20	2.61	111.0
Apr.	27.02	42.00	"	12.4	8.02	142.0	139.0	43	7.81	1.80	10.70	0.07	2.6	0.23	3.56	167.0
May.	29.30	61.00	High	8.9	8.01	146.0	131.0	48	7.73	2.10	11.70	0.08	3.0	0.38	3.82	171.0
Jun.	30.33	64.00	"	5.6	7.95	171.0	161.0	41	7.57	2.40	13.10	0.12	4.5	0.42	4.53	262.0
Jul.	28.10	70.00	"	400.7	7.54	162.0	96.0	39	6.76	2.30	10.30	0.05	3.3	0.45	2.13	901.0
Aug.	26.78	77.00	Low	1001	8.23	121.0	82.0	14	7.20	1.70	6.50	0.02	3.4	0.56	1.75	1602.0
Sep.	28.34	70.00	"	1000	7.72	125.0	94.0	25	7.73	1.20	8.60	0.04	3.1	0.40	2.00	241.0
Oct.	26.10	41.00	High	100.5	8.01	133.0	127.0	31	7.68	1.50	7.40	0.05	3.2	0.27	2.12	114.0
Nov.	22.04	30.00	Med	31.2	7.90	134.0	133.0	41	7.80	1.10	10.20	0.05	2.9	0.21	2.13	107.0
Dec.	17.30	24.00	Low	16.0	8.50	127.0	104.0	32	8.16	1.50	9.10	0.04	2.2	0.20	2.47	66.0

Table - 6

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station II **Jan.2002 - Dec -2002**

Parameter	W.T.	Tur.	Water Current	P^H	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH_4N	Co_2	Po_4	So_4	MPN
W.T.	1.00														
Tur.	0.83	1.00													
Water Current	0.37	0.72	1.00												
P^H	-0.35	-0.33	-0.15	1.00											
T.A.	0.6	0.36	-0.3	-0.34	1.00										
T.H.	0.01	-0.39	-0.78	-0.03	0.43	1.00									
Cl.	0.27	-0.16	-0.66	-0.22	0.67	0.57	1.00								
D.O.	0.74	-0.75	-0.41	0.2	-0.53	0.37	-0.07	1.00							
B.O.D.	0.51	0.32	-0.24	-0.23	0.81	0.24	0.66	-0.54	1.00						
C.O.D.	0.38	0.06	-0.51	-0.18	0.81	0.61	0.84	-0.12	0.71	1.00					
NH_4N	0.64	0.26	-0.33	-0.07	0.82	0.59	0.72	0.1	-0.04	0.36	1.00				
Co_2	0.9	0.71	0.22	-0.12	0.69	0.11	0.32	0.73	0.68	0.48	0.04	1.00			
Po_4	0.73	0.96	0.73	-0.17	0.31	-0.45	-0.23	-0.77	0.35	-0.04	-0.12	0.7	1.00		
So_4	0.24	-0.07	-0.59	0.004	0.56	0.77	0.66	0.25	0.46	0.79	0.4	0.33	-0.11	1.00	
MPN	0.34	0.71	0.71	0.002	0.01	-0.64	-0.47	-0.69	0.23	-0.36	-0.3	0.35	0.82	-0.41	1.00

Statistical Values of Ken River
Station - 2

S.No.	Parameter	2002				2003				Total			
		Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
1	W.T.	24.69	4.29	30.33	18.01	24.12	5.57	31.27	14.20	24.40	4.93	30.80	16.10
2	Tur.	48.75	17.65	77.00	24.00	49.08	17.60	76.00	25.00	48.90	17.63	76.50	24.50
3	Water Current	218.55	365.42	1000.9	5.60	218.59	365.33	1000.6	5.70	218.57	365.38	1000.75	5.65
4	P^H	7.97	0.23	8.50	7.54	7.96	0.24	8.49	7.69	7.96	0.24	8.49	7.62
5	T.A.	137.33	15.00	171.00	121.0	173.33	15.24	171.00	122.0	155.33	15.12	171.00	121.50
6	T.H.	121.75	22.40	161.00	82.00	121.75	22.43	162.00	83.00	121.75	22.42	161.50	82.50
7	Cl.	33.50	8.97	48.00	14.00	33.58	9.53	49.00	15.00	33.54	9.25	48.50	14.50
8	D.O.	7.80	0.51	8.91	6.76	7.80	0.51	8.90	6.76	7.80	0.51	8.90	6.76
9	B.O.D.	1.75	0.38	1.20	2.40	1.69	0.39	2.30	1.10	1.72	0.39	1.75	1.75
10	C.O.D.	9.09	1.76	13.10	6.50	9.27	1.62	13.00	6.40	9.18	1.69	13.05	6.45
11	NH_4N	0.04	0.03	0.12	0.02	0.05	0.03	0.13	0.02	0.05	0.03	0.22	0.04
12	Co_2	2.91	0.73	4.50	1.70	2.93	0.72	4.50	1.60	2.92	0.73	4.50	1.65
13	po_4	0.14	0.12	0.56	0.19	0.15	0.12	0.57	0.19	0.14	0.12	2.48	0.06
14	So_4	2.76	0.81	4.53	1.75	2.79	0.83	4.63	1.65	2.78	0.82	4.60	1.70
15	MPN	323.7	443.15	1602.0	57.00	324.41	444.43	1604.0	55.00	324.03	443.79	1603.00	56

Table - 7

Physico-Chemical Characteristics of Ken River

Station - III **Period : 2002**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D .ppm.	C.O.D. ppm.	NH_4 - N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	19.02	29.00	Low	10.2	7.75	120.0	126.0	29	8.90	1.40	8.20	0.02	1.6	0.18	3.22	56.0
Feb.	21.03	36.00	Med	15.6	8.02	131.0	145.0	27	8.26	1.30	8.80	0.02	2.1	0.21	2.66	83.0
Mar.	24.03	39.00	"	20.4	8.03	135.0	121.0	30	8.02	1.60	10.50	0.03	2.5	0.19	2.62	109.0
Apr.	28.03	43.00	"	12.5	8.02	143.0	141.0	42	7.81	1.80	10.60	0.08	3.1	0.20	3.55	169.0
May.	30.31	61.00	High	8.8	8.01	145.0	131.0	47	7.72	2.00	11.80	0.08	3.5	0.35	3.81	170.0
Jun.	31.32	65.00	"	5.7	7.94	170.0	160.0	42	7.67	2.50	13.20	0.10	4.3	0.40	4.52	260.0
Jul.	28.11	69.00	"	400.8	7.53	161.0	95.0	39	6.75	2.20	10.20	0.03	3.4	0.43	2.14	900.0
Aug.	26.78	76.00	Low	1000.8	8.24	121.0	81.0	15	7.21	1.80	6.40	0.02	3.5	0.52	1.76	1600.0
Sep.	28.35	71.00	"	1000.3	7.71	124.0	94.0	27	7.74	1.30	8.50	0.03	3.2	0.40	2.10	241.0
Oct.	27.11	42.00	High	100.6	8.00	132.0	127.0	30	7.67	1.60	7.50	0.04	3.3	0.26	2.15	114.0
Nov.	23.07	31.00	Med	31.3	7.91	135.0	134.0	40	7.81	2.20	10.40	0.05	2.8	0.20	2.32	107.0
Dec.	18.31	25.00	Low	16.0	8.51	126.0	103.0	33	8.15	1.50	9.20	0.04	2.1	0.19	2.45	65.0

Table-8

Matrix showing correlation of Coefficient among various Physico- Chemical Parameters

Sation-3 **Jan-2002-Dec-2002**

Parameter	W.T.	Tur.	Water Current	P^H	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH_4N	Co_2	po_4	So_4	MPN
W.T.	1.00														
Tur.	0.80	1.00													
Water Current	0.29	0.72	1.00												
P^H	-0.33	-0.32	-0.16	1.00											
T.A.	0.63	0.36	-0.3	-0.33	1.00										
T.H.	0.09	-0.38	-0.78	-0.03	0.44	1.00									
Cl.	0.36	-0.09	-0.61	-0.21	0.71	0.56	1.00								
D.O.	-0.68	-0.74	-0.49	0.20	-0.5	0.41	-0.1	1.00							
B.O.D.	0.58	0.36	-0.17	-0.18	0.82	0.28	0.61	-0.57	1.00						
C.O.D.	0.42	0.05	-0.53	-0.15	0.81	0.62	0.86	-0.08	0.67	1.00					
NH_4N	0.60	0.15	-0.41	0.08	0.69	0.62	0.79	-0.14	0.66	0.81	1.00				
Co_2	0.94	0.79	0.31	-0.16	0.66	0.05	0.3	-0.76	0.71	0.39	0.61	1.00			
po_4	0.67	0.96	0.75	-0.21	0.28	-0.48	-0.2	-0.75	0.38	-0.07	0.05	0.74	1.00		
So_4	0.32	-0.03	-0.58	-0.02	0.57	0.77	0.66	0.28	0.41	0.78	0.81	0.25	-0.13	1.00	
MPN	0.30	0.69	0.71	0.001	0.01	-0.64	-0.46	-0.69	0.25	-0.38	-0.26	0.41	0.8	-0.41	1.00

Statistical Values of Ken River
Station - 3

S.No.	Parameter	2002				2003				Total			
		Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
1	W.T.	25.45	4.13	31.32	18.31	24.12	5.57	31.28	14.21	24.78	4.85	31.30	16.26
2	Tur.	48.91	70.48	76.00	25.00	47.41	17.11	76.00	25.00	48.16	43.80	76.00	25.00
3	Water Current	218.58	365.36	1000.8	5.70	218.54	365.51	1000.9	5.30	218.56	365.44	1000.85	5.50
4	P^H	7.97	0.24	8.51	7.53	7.98	0.25	8.56	7.55	7.79	0.25	8.53	7.63
5	T.A.	136.91	14.91	170.00	120.0	135.66	14.61	168.00	120.0	136.28	14.76	169.00	120.00
6	T.H.	121.50	22.66	160.00	81.00	121.08	22.47	158.00	82.00	121.29	22.57	159.00	81.50
7	Cl.	33.41	8.96	47.00	15.00	32.00	9.10	46.00	12.00	32.70	9.03	46.50	13.50
8	D.O.	7.80	0.51	8.90	6.75	7.80	0.51	8.91	6.75	7.80	0.51	8.90	6.75
9	B.O.D.	1.76	0.37	2.50	1.30	1.70	0.38	2.40	1.30	1.73	0.38	2.45	1.30
10	C.O.D.	9.60	1.81	13.20	6.40	9.45	1.91	13.10	6.30	9.52	1.86	13.15	6.90
11	NH_4N	0.03	0.03	0.10	0.02	0.04	0.02	0.10	0.02	0.03	0.03	0.10	0.02
12	Co_2	2.95	0.73	4.30	1.60	2.98	0.82	4.70	1.60	2.96	0.78	4.50	1.60
13	po_4	0.14	0.11	0.52	0.18	0.14	0.11	0.51	0.18	0.14	0.11	0.23	0.05
14	So_4	2.77	0.79	4.52	1.76	2.18	0.80	4.62	1.86	2.79	0.80	4.57	1.81
15	MPN	322.8	442.82	1600.0	56.00	314.58	438.60	1580.0	54.00	318.70	440.71	1590.00	55.0

Table - 9

Physico-Chemical Characteristics of Ken River

Station - IV **Period : 2002**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D. ppm.	C.O.D. ppm.	NH_4 - N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	19.01	31.00	Low	10.0	7.76	121.0	125.0	28	8.92	1.30	8.10	0.01	1.7	0.18	3.21	55.0
Feb.	21.02	38.00	Med	15.5	8.01	130.0	146.0	26	8.27	1.30	8.90	0.02	2.1	0.22	2.67	82.0
Mar.	24.03	41.00	"	20.2	8.02	134.0	121.0	30	8.03	1.50	10.20	0.04	2.6	0.20	2.62	110.0
Apr.	30.31	42.00	"	12.1	8.01	142.0	140.0	43	7.82	1.80	10.50	0.07	3.0	0.21	3.55	165.0
May.	31.32	60.00	High	8.5	8.02	146.0	132.0	48	7.73	2.00	11.80	0.08	3.5	0.33	3.81	169.0
Jun.	31.32	65.00	"	5.3	7.95	171.0	160.0	43	7.68	2.50	13.00	0.11	4.3	0.41	4.53	259.0
Jul.	28.11	78.00	"	400.5	7.54	160.0	96.0	38	6.76	2.10	10.30	0.04	3.5	0.42	2.13	901.0
Aug.	26.78	77.00	Low	1000.5	8.22	121.0	81.0	14	7.22	1.90	6.50	0.02	3.5	0.51	1.74	1601.0
Sep.	28.35	71.00	"	1000.4	7.70	124.0	93.0	28	7.75	1.40	8.60	0.03	3.2	0.42	2.00	240.0
Oct.	27.10	42.00	High	100.3	8.01	135.0	126.0	31	7.67	1.60	7.60	0.04	3.3	0.28	2.13	113.0
Nov.	23.08	31.00	Med	30.0	7.92	134.0	133.0	40	7.82	2.10	10.50	0.05	2.7	0.20	2.31	106.0
Dec.	18.30	26.00	Low	15.0	8.50	125.0	104.0	32	8.15	1.60	9.30	0.03	2.2	0.19	2.46	64.0

Table - 10

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station IV **Jan.2002 - Dec -2002**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.7	1.00													
Water Current	0.24	0.71	1.00												
P^H	-0.3	-0.4	-0.18	1.00											
T.A.	0.64	0.39	-0.31	-0.33	1.00										
T.H.	0.12	-0.42	-0.78	-0.01	0.46	1.00									
Cl.	0.47	-0.07	-0.58	-0.2	0.71	0.58	1.00								
D.O.	-0.64	-0.77	-0.48	0.2	-0.49	0.4	-0.1	1.00							
B.O.D.	0.61	0.44	-0.06	-0.06	0.79	0.22	0.56	-0.62	1.00						
C.O.D.	0.44	0.05	-0.52	-0.14	0.8	0.62	0.88	-0.11	0.64	1.00					
NH_4N	0.72	0.22	-0.35	-0.01	0.82	0.6	0.8	-0.27	0.78	0.86	1.00				
Co_2	0.89	0.77	0.32	-0.16	0.69	0.01	0.33	-0.77	0.78	0.4	0.7	1.00			
Po_4	0.62	0.96	0.77	-0.23	0.29	0.46	-0.2	-0.74	0.46	-0.07	0.17	0.78	1.00		
So_4	0.35	-0.09	-0.59	0.001	0.59	0.78	0.67	0.29	0.4	0.76	0.77	0.23	-0.16	1.00	
MPN	0.26	0.72	0.71	-0.01	0.005	-0.64	-0.47	-0.68	0.32	-0.37	-0.18	0.43	0.78	-0.41	1.00

Statistical Values of Ken River
Station - 4

S.No.	Parameter	2002				2003				Total			
		Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
1	W.T.	25.45	4.13	31.32	18.30	24.13	5.57	31.28	14.20	24.29	4.85	31.30	16.25
2	Tur.	49.50	17.18	77.00	26.00	48.83	16.99	78.00	26.00	49.16	17.09	77.50	26.00
3	Water Current	218.19	365.50	1000.5	5.30	218.10	365.21	1000.8	5.60	218.14	365.36	1000.65	5.45
4	P^H	7.97	0.23	8.50	7.54	8.01	0.27	8.26	7.59	7.99	0.25	8.38	7.56
5	T.A.	136.90	14.96	171.00	121.0	135.75	12.78	168.00	120.0	136.32	13.87	169.50	120.50
6	T.H.	121.58	22.56	160.00	81.00	122.00	22.18	160.00	82.00	121.79	22.37	163.50	81.50
7	Cl.	33.41	8.99	48.00	14.00	33.00	8.97	46.00	13.00	33.20	8.98	47.00	13.50
8	D.O.	7.81	0.51	8.92	6.76	7.89	0.58	8.92	6.76	7.85	0.55	8.92	6.76
9	B.O.D.	1.76	0.36	2.60	1.30	1.68	0.34	2.00	1.20	1.72	0.35	2.30	1.25
10	C.O.D.	9.60	1.74	13.00	6.50	9.41	1.61	12.80	6.40	9.50	1.68	12.90	6.45
11	NH_4N	0.05	0.03	0.11	0.01	0.05	0.03	0.12	0.02	0.04	0.03	0.12	0.02
12	Co_2	2.96	0.70	4.30	1.70	3.04	0.67	4.20	1.70	3.00	0.69	4.25	1.70
13	po_4	0.14	0.11	0.51	0.18	0.15	0.11	0.51	0.18	0.15	0.11	0.25	0.06
14	So_4	2.76	0.81	4.53	1.74	2.76	0.81	4.67	1.96	2.76	0.81	4.60	1.85
15	MPN	322.08	443.52	1601.0	55.00	318.91	446.04	1606.0	52.00	320.49	444.78	1603.50	53.5

Table - 11

Physico-Chemical Characteristics of Ken River

Station - V **Period : 2002**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D. ppm.	C.O.D. ppm.	NH_4 - N ppm.	Co_2 ppm.	PO_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	19.01	31.00	Low	10.0	7.76	121.0	125.0	28	8.92	1.30	8.10	0.01	1.7	0.18	3.21	55.0
Feb.	21.02	38.00	Med	15.5	8.01	130.0	146.0	26	8.27	1.30	8.90	0.02	2.1	0.22	2.67	82.0
Mar.	24.03	41.00	"	20.2	8.02	134.0	121.0	30	8.03	1.50	10.20	0.04	2.6	0.20	2.62	110.0
Apr.	30.31	42.00	"	12.1	8.01	142.0	140.0	43	7.82	1.80	10.50	0.07	3.0	0.21	3.55	165.0
May.	31.32	60.00	High	8.5	8.02	146.0	132.0	48	7.73	2.00	11.80	0.08	3.5	0.33	3.81	169.0
Jun.	31.32	65.00	"	5.3	7.95	171.0	160.0	43	7.68	2.50	13.00	0.11	4.3	0.41	4.53	259.0
Jul.	28.11	78.00	"	400.5	7.54	160.0	96.0	38	6.76	2.10	10.30	0.04	3.5	0.42	2.13	901.0
Aug.	26.78	77.00	Low	1000.5	8.22	121.0	81.0	14	7.22	1.90	6.50	0.02	3.5	0.51	1.74	1601.0
Sep.	28.35	71.00	"	1000.4	7.70	124.0	93.0	28	7.75	1.40	8.60	0.03	3.2	0.42	2.00	240.0
Oct.	27.10	42.00	High	100.3	8.01	135.0	126.0	31	7.67	1.60	7.60	0.04	3.3	0.28	2.13	113.0
Nov.	23.08	31.00	Med	30.0	7.92	134.0	133.0	40	7.82	2.10	10.50	0.05	2.7	0.20	2.31	106.0
Dec.	18.30	26.00	Low	15.0	8.50	125.0	104.0	32	8.15	1.60	9.30	0.03	2.2	0.19	2.46	64.0

Table - 12

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station V — **Jan.2002 - Dec -2002**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.81	1.00													
Water Current	0.35	0.74	1.00												
P^H	-0.4	-0.36	-0.18	1.00											
T.A.	0.67	0.38	-0.26	-0.35	1.00										
T.H.	-0.02	-0.47	-0.81	-0.01	0.38	1.00									
Cl.	0.4	-0.11	-0.6	-0.2	0.7	0.74	1.00								
D.O.	-0.73	-0.75	0.47	0.21	-0.55	-0.56	-0.13	1.00							
B.O.D.	0.59	0.42	-0.1	-0.18	0.82	-0.03	0.59	-0.63	1.00						
C.O.D.	0.4	0.05	-0.51	-0.16	0.77	0.53	0.88	-0.12	0.65	1.00					
NH_4N	0.59	0.21	-0.35	0.02	0.81	0.59	0.73	-0.25	0.68	0.79	1.00				
Co_2	0.92	0.75	0.32	-0.13	0.69	0.12	0.32	-0.77	0.68	0.38	0.7	1.00			
Po_4	0.7	0.96	0.79	-0.22	0.3	0.4	-0.23	-0.75	0.42	-0.07	0.19	0.74	1.00		
So_4	0.25	-0.07	-0.58	-0.01	0.56	0.61	0.67	0.25	0.4	0.77	0.78	0.23	-0.17	1.00	
MPN	0.34	0.71	0.71	-0.01	0.04	-0.67	-0.48	-0.68	0.33	-0.37	-0.19	0.41	0.79	-0.40	1.00

Statistical Values of Ken River
Station - 5

S.No.	Parameter	2002				2003				Total			
		Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.	Mean	Std. Dev.	Max.	Min.
1	W.T.	24.42	4.28	30.00	17.00	24.06	5.61	31.25	14.00	24.24	4.95	30.72	15.50
2	Tur.	47.41	17.47	75.00	42.00	47.25	17.48	74.00	27.00	47.33	17.48	74.50	25.50
3	Water Current	218.52	365.43	1000.8	5.60	218.60	365.41	1000.9	5.70	218.56	365.42	1000.85	5.65
4	P^H	7.98	0.23	8.52	7.56	7.90	0.26	8.25	7.68	7.98	0.25	8.38	7.62
5	T.A.	139.16	15.44	172.00	120.0	136.91	15.35	173.00	120.0	138.03	15.40	172.50	120.00
6	T.H.	121.58	21.73	150.00	80.00	121.50	21.30	149.00	80.00	121.54	21.52	162.50	80.00
7	Cl.	33.08	8.87	47.00	14.00	33.00	8.85	45.00	14.00	33.04	8.86	47.50	14.00
8	D.O.	7.81	0.51	8.93	6.77	7.89	0.58	8.93	6.77	7.85	0.55	8.93	6.77
9	B.O.D.	1.82	0.35	2.60	1.30	1.80	0.31	2.50	1.30	1.81	0.33	2.55	1.30
10	C.O.D.	9.57	1.78	13.10	6.40	9.56	1.78	13.20	6.50	9.56	1.78	13.15	6.45
11	NH_4N	0.05	0.03	0.12	0.02	0.04	0.02	0.10	0.02	0.04	0.03	0.11	0.02
12	Co_2	2.80	0.70	4.20	2.00	2.84	0.66	4.10	1.50	2.82	0.68	7.15	1.75
13	po_4	0.12	0.11	0.50	0.17	0.125	0.11	0.50	0.17	0.122	0.11	0.205	0.06
14	So_4	2.75	0.76	4.52	1.74	2.74	0.80	4.52	1.76	2.74	0.78	4.52	1.75
15	MPN	207.00	443.75	1600.0	62.00	200.50	219.85	901.0	54.00	203.75	331.80	1250.50	58.0

Table - 13

Physico-Chemical Characteristics of Ken River

Station - I **Period : 2003**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	P^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D. ppm.	C.O.D. ppm.	NH_4 - N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	14.19	30.00	Low	10.2	7.79	121.0	125.0	28	8.91	1.50	8.20	0.01	1.5	0.19	3.20	55.0
Feb.	18.16	37.00	Med	15.7	8.03	129.0	145.0	27	8.28	1.30	8.80	0.03	2.1	0.22	2.67	83.0
Mar.	22.61	39.00	"	20.3	8.03	134.0	121.0	31	8.03	1.50	10.30	0.04	2.7	0.21	2.61	111.0
Apr.	26.23	41.00	"	12.4	8.03	144.0	141.0	45	7.80	1.90	10.70	0.06	2.8	0.23	3.54	169.0
May.	30.48	61.00	High	8.6	8.01	146.0	130.0	48	7.73	2.00	12.00	0.08	3.8	0.37	3.80	172.0
Jun.	31.27	66.00	"	5.8	7.95	169.0	161.0	41	7.55	2.40	13.00	0.10	4.6	0.41	4.54	260.0
Jul.	30.06	70.00	"	400.5	7.52	160.0	96.0	37	6.75	2.30	10.20	0.05	3.7	0.43	2.13	902.0
Aug.	28.16	76.00	Low	1000.9	8.23	121.0	81.0	16	7.20	1.90	6.40	0.02	3.4	0.53	1.74	1600.0
Sep.	27.03	71.00	"	1000.4	7.70	125.0	92.0	25	7.73	1.00	8.60	0.03	3.1	0.38	2.00	242.0
Oct.	27.74	40.00	High	100.7	8.03	133.0	127.0	33	7.70	1.30	7.60	0.05	3.3	0.27	2.20	113.0
Nov.	20.10	31.00	Med	30.2	7.93	132.0	134.0	41	7.80	2.10	10.30	0.07	2.7	0.21	2.35	109.0
Dec.	15.87	26.00	Low	16.1	8.50	127.0	104.0	33	8.10	1.60	9.10	0.03	2.2	0.20	2.42	66.0

Table - 14

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station 1 **Jan.2003 - Dec -2003**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4 N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.82	1.00													
Water Current	0.37	0.72	1.00												
P^H	0.08	-0.03	0.04	1.00											
T.A.	0.50	0.13	-0.49	0.08	1.00										
T.H.	0.00	-0.38	-0.77	-0.07	0.76	1.00									
Cl.	0.32	-0.14	-0.61	0.19	0.66	0.55	1.00								
D.O.	0.74	-0.74	-0.47	-0.18	-0.12	0.37	-0.11	1.00							
B.O.D.	0.45	0.30	-0.25	-0.01	0.67	0.28	0.56	-0.51	1.00						
C.O.D.	0.40	0.09	-0.50	0.25	0.84	0.60	0.82	-0.15	0.68	1.00					
NH_4N	0.45	0.02	-0.53	0.31	0.94	0.70	0.81	-0.16	0.67	0.92	1.00				
Co_2	0.21	0.75	0.22	0.14	0.64	0.08	0.33	-0.77	0.69	0.50	0.58	1.00			
Po_4	0.73	0.96	0.73	-0.04	0.05	-0.44	-0.21	-0.74	0.34	-0.03	-0.07	0.72	1.00		
So_4	0.24	-0.04	-0.59	-0.06	0.86	0.77	0.64	0.24	0.51	0.78	0.78	0.30	0.10	1.00	
MPN	0.37	0.70	0.71	-0.14	0.29	-0.64	-0.46	-0.68	0.28	-0.35	-0.38	0.41	0.81	-0.40	1.00

Table - 15

Physico-Chemical Characteristics of Ken River

Station - II **Period : 2003**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D. ppm.	C.O.D. ppm.	NH_4- N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	14.19	30.00	Low	10.2	7.79	121.0	125.0	28	8.91	1.50	8.20	0.01	1.5	0.19	3.20	55.0
Feb.	18.16	37.00	Med	15.7	8.03	129.0	145.0	27	8.28	1.30	8.80	0.03	2.1	0.22	2.67	83.0
Mar.	22.61	39.00	"	20.3	8.03	134.0	121.0	31	8.03	1.50	10.30	0.04	2.7	0.21	2.61	111.0
Apr.	26.23	41.00	"	12.4	8.03	144.0	141.0	45	7.80	1.90	10.70	0.06	2.8	0.23	3.54	169.0
May.	30.48	61.00	High	8.6	8.01	146.0	130.0	48	7.73	2.00	12.00	0.08	3.8	0.37	3.80	172.0
Jun.	31.27	66.00	"	5.8	7.95	169.0	161.0	41	7.55	2.40	13.00	0.10	4.6	0.41	4.54	260.0
Jul.	30.06	70.00	"	400.5	7.52	160.0	96.0	37	6.75	2.30	10.20	0.05	3.7	0.43	2.13	902.0
Aug.	28.16	76.00	Low	1000.9	8.23	121.0	81.0	16	7.20	1.90	6.40	0.02	3.4	0.53	1.74	1600.0
Sep.	27.03	71.00	"	1000.4	7.70	125.0	92.0	25	7.73	1.00	8.60	0.03	3.1	0.38	2.00	242.0
Oct.	27.74	40.00	High	100.7	8.03	133.0	127.0	33	7.70	1.30	7.60	0.05	3.3	0.27	2.20	113.0
Nov.	20.10	31.00	Med	30.2	7.93	132.0	134.0	41	7.80	2.10	10.30	0.07	2.7	0.21	2.35	109.0
Dec.	15.87	26.00	Low	16.1	8.50	127.0	104.0	33	8.10	1.60	9.10	0.03	2.2	0.20	2.42	66.0

Table - 16

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station II **Jan.2003 - Dec -2003**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.83	1.00													
Water Current	0.35	0.7	1.00												
P^H	-0.28	-0.37	-0.19	1.00											
T.A.	0.6	0.36	-0.31	-0.36	1.00										
T.H.	-0.005	-0.36	-0.76	-0.01	0.46	1.00									
Cl.	0.33	-0.04	-0.6	-0.17	0.73	0.61	1.00								
D.O.	-0.81	-0.75	-0.48	0.23	-0.52	0.38	-0.12	1.00							
B.O.D.	0.57	0.35	-0.24	-0.23	0.8	0.25	0.75	-0.54	1.00						
C.O.D.	0.29	0.1	-0.47	-0.23	0.83	0.61	0.85	-0.15	0.72	1.00					
NH_4N	0.6	0.29	-0.31	-0.12	0.84	0.54	0.8	-0.34	0.81	0.85	1.00				
Co_2	0.92	0.69	0.15	-0.15	0.74	0.21	0.5	-0.71	0.71	0.56	0.83	1.00			
Po_4	-0.27	-0.17	0.03	0.63	-0.16	-0.38	-0.13	0.01	-0.14	-0.05	-0.1	-0.19	1.00		
So_4	0.16	-0.03	-0.6	-0.03	0.58	0.78	0.74	0.25	0.5	0.77	0.75	0.39	-0.16	1.00	
MPN	0.44	0.7	0.71	-0.03	0.005	-0.64	-0.43	-0.69	0.19	-0.33	-0.12	0.3	0.04	-0.44	1.00

Table - 17

Physico-Chemical Characteristics of Ken River

Station - III **Period : 2003**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D.ppm.	C.O.D. ppm.	NH_4- N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	14.21	28.00	Low	10.3	7.80	120.0	125.0	28	8.91	1.30	8.10	0.03	1.6	0.18	3.24	54.0
Feb.	18.61	34.00	Med	15.4	8.02	128.0	143.0	26	8.26	1.30	8.60	0.02	2.2	0.20	2.67	72.0
Mar.	22.62	37.00	"	20.3	8.01	137.0	122.0	29	8.03	1.50	10.40	0.03	2.3	0.19	2.64	102.0
Apr.	26.24	42.00	"	12	8.01	140.0	140.0	41	7.80	1.70	10.90	0.07	3.2	0.20	3.58	140.0
May.	30.49	58.00	High	8.7	8.00	142.0	137.0	46	7.72	2.00	12.20	0.06	3.4	0.36	3.87	165.0
Jun.	31.28	63.00	"	5.3	7.96	168.0	158.0	43	7.56	2.40	13.10	0.10	4.7	0.41	4.62	252.0
Jul.	30.07	65.00	"	400.9	7.55	160.0	92.0	38	6.75	2.20	9.20	0.05	3.6	0.42	2.18	886.0
Aug.	28.20	76.00	Low	1000.7	8.24	120.0	82.0	12	7.22	1.80	6.30	0.02	3.5	0.51	1.86	1580.0
Sep.	27.04	70.00	"	1000.9	7.68	123.0	93.0	25	7.73	1.20	7.90	0.04	3.3	0.41	2.20	242.0
Oct.	27.75	40.00	High	100.7	8.03	128.0	125.0	27	7.70	1.60	7.40	0.04	3.3	0.25	2.10	112.0
Nov.	20.11	31.00	Med	31.4	7.93	134.0	132.0	37	7.81	2.10	10.20	0.05	2.7	0.20	2.42	106.0
Dec.	15.88	25.00	Low	16.0	8.56	126.0	104.0	32	8.16	1.40	9.10	0.03	2.0	0.19	2.45	64.0

Table - 18

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station III **Jan.2003 - Dec -2003**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.83	1.00													
Water Current	0.35	0.75	1.00												
P^H	-0.31	-0.34	-0.19	1.00											
T.A.	0.58	0.31	-0.3	-0.34	1.00										
T.H.	-0.04	-0.4	-0.79	0.01	0.39	1.00									
Cl.	0.26	-0.11	-0.62	-0.2	0.73	0.61	1.00								
D.O.	-0.81	-0.75	-0.47	0.23	-0.53	0.39	-0.09	1.00							
B.O.D.	0.62	0.39	-0.14	-0.18	0.81	0.24	0.57	-0.65	1.00						
C.O.D.	0.29	-0.03	-0.59	-0.06	0.75	0.71	0.89	-0.04	0.58	1.00					
NH_4N	0.56	0.27	-0.3	-0.23	0.81	0.57	0.79	-0.3	0.71	0.81	1.00				
Co_2	0.93	0.78	0.3	-0.24	0.67	0.09	0.3	-0.77	0.72	0.36	0.72	1.00			
Po_4	0.76	0.97	0.74	-0.24	0.29	-0.45	-0.16	-0.75	0.44	-0.09	0.22	0.76	1.00		
So_4	0.2	-0.01	-0.54	-0.04	0.57	0.78	0.71	0.21	0.39	0.84	0.77	0.32	-0.06	1.00	
MPN	0.44	0.71	0.72	-0.01	0.02	-0.65	-0.47	-0.68	0.31	-0.42	-0.18	0.4	0.77	-0.39	1.00

Table - 19

Physico-Chemical Characteristics of Ken River

Station - IV **Period : 2003**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	p^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D.ppm.	C.O.D. ppm.	NH_4- N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	14.20	31.00	Low	9.0	7.81	120.0	122.0	28	8.92	1.20	8.20	0.02	1.7	0.18	3.23	52.0
Feb.	18.62	37.00	Med	14.6	8.02	128.0	144.0	27	8.27	1.20	8.70	0.02	2.3	0.22	2.65	78.0
Mar.	22.63	40.00	"	18.9	8.03	132.0	125.0	31	8.04	1.40	10.10	0.03	2.6	0.21	2.62	100.0
Apr.	26.25	43.00	"	13.2	8.02	140.0	142.0	40	7.81	1.70	10.40	0.06	3.2	0.22	3.43	145.0
May.	30.49	58.00	High	8.5	8.01	145.0	136.0	46	7.73	1.90	10.90	0.08	3.6	0.34	3.71	165.0
Jun.	31.28	63.00	"	5.6	7.99	160.0	160.0	45	7.57	2.30	12.80	0.12	4.2	0.41	4.67	258.0
Jul.	30.08	70.00	"	400.9	7.59	158.0	98.0	36	6.76	2.00	10.30	0.06	3.5	0.43	2.34	898.0
Aug.	28.21	78.00	Low	1000.8	8.26	122.0	82.0	13	7.23	1.90	6.40	0.03	3.6	0.51	1.84	1606.0
Sep.	27.05	70.00	"	998.4	7.69	125.0	92.0	27	7.74	1.40	8.70	0.04	3.2	0.41	1.96	248.0
Oct.	24.76	40.00	High	100.7	8.04	135.0	124.0	31	7.71	1.50	7.60	0.04	3.4	0.29	2.10	114.0
Nov.	20.12	30.00	Med	30.7	7.96	132.0	128.0	42	7.82	2.00	9.80	0.06	2.8	0.21	2.20	103.0
Dec.	15.89	26.00	Low	16.0	8.69	124.0	106.0	30	8.17	1.50	9.10	0.04	2.4	0.20	2.38	60.0

Table - 20

Matrix Showing Correlation of Coefficient among various Physico - Chemical

Station IV **Jan.2003 - Dec -2003**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.84	1.00													
Water Current	0.37	0.75	1.00												
P^H	-0.34	-0.37	-0.19	1.00											
T.A.	0.7	0.38	-0.25	-0.36	1.00										
T.H.	-0.005	-0.4	-0.8	-0.02	0.43	1.00									
Cl.	0.29	-0.16	-0.63	-0.22	0.71	0.69	1.00								
D.O.	-0.82	-0.75	-0.48	0.22	-0.6	0.33	-0.08	1.00							
B.O.D.	0.7	0.49	0.06	-0.06	0.73	0.13	0.5	-0.71	1.00						
C.O.D.	0.39	0.03	-0.5	-0.19	0.79	0.65	0.87	-0.15	0.54	1.00					
NH_4N	0.65	0.32	-0.23	-0.11	0.83	0.5	0.78	-0.43	0.84	0.83	1.00				
Co_2	0.94	0.74	0.31	-0.13	0.7	0.05	0.31	-0.81	0.8	0.37	0.74	1.00			
Po_4	0.8	0.96	0.75	-0.24	0.36	-0.44	-0.21	-0.79	0.56	-0.04	0.34	0.78	1.00		
So_4	0.25	-0.01	-0.55	-0.07	0.57	0.79	0.67	0.17	0.36	0.77	0.71	0.26	-0.08	1.00	
MPN	0.47	0.74	0.72	-0.02	0.05	-0.63	-0.52	-0.68	0.41	-0.37	-0.05	0.44	0.79	-0.34	1.00

Table - 21

Physico-Chemical Characteristics of Ken River

Station - V **Period : 2003**

Month	W. Temp 0c	Tur. N.T.U.	Light penetration	Water current Cu-m./Sec.	P^H	T.A. ppm.	T.H. ppm.	Cl. ppm.	D.O. ppm.	B.O.D.ppm.	C.O.D. ppm.	NH_4- N ppm.	Co_2 ppm.	Po_4 ppm.	So_4 ppm.	MPN. Org/l
Jan.	14.00	27.00	Low	10.2	7.80	120.0	123.0	27	8.93	1.50	8.00	0.02	1.5	0.17	3.10	54.0
Feb.	18.45	34.00	Med	15.8	8.02	128.0	142.0	24	8.28	1.40	8.90	0.02	2.2	0.20	2.65	81.0
Mar.	22.60	40.00	"	20.1	8.02	132.0	122.0	32	8.05	1.60	10.10	0.03	2.5	0.19	2.61	108.0
Apr.	26.23	40.00	"	12.4	8.01	142.0	141.0	41	8.80	1.80	10.50	0.05	3.1	0.21	3.54	163.0
May.	30.45	57.00	High	8.8	8.02	146.0	132.0	45	7.72	2.10	11.80	0.07	3.2	0.31	3.82	169.0
Jun.	31.25	61.00	"	5.7	7.98	173.0	149.0	42	7.56	2.20	13.20	0.10	4.1	0.38	4.52	259.0
Jul.	30.00	70.00	"	400.9	7.58	160.0	97.0	37	6.77	2.30	10.20	0.03	3.1	0.41	2.14	901.0
Aug.	28.15	74.00	Low	1000.9	8.25	122.0	80.0	12	7.22	1.80	6.50	0.02	3.3	0.50	1.76	1590.0
Sep.	27.00	71.00	"	1000.4	7.68	126.0	91.0	28	7.75	1.30	8.80	0.03	3.2	0.40	2.00	234.0
Oct.	24.73	39.00	High	100.6	8.03	135.0	126.0	32	7.72	1.70	7.40	0.05	3.2	0.27	2.10	113.0
Nov.	20.10	29.00	Med	31.4	7.94	134.0	135.0	40	7.80	2.00	10.30	0.04	2.5	0.20	2.32	103.0
Dec.	15.80	25.00	Low	16.0	8.66	125.0	103.0	31	8.16	1.60	9.10	0.03	2.2	0.19	2.41	62.0

Table - 22

Matrix Showing Correlation of Coefficient among various Physico - Chemical Parameters

Station V **Jan.2003 - Dec -2003**

Parameter	W.T.	Tur.	Water Current	PH	T.A.	T.H.	Cl.	D.O.	B.O.D.	C.O.D.	NH4 N	Co2	Po4	So4	MPN
W.T.	1.00														
Tur.	0.85	1.00													
Water Current	0.37	0.75	1.00												
P^H	-0.33	-0.38	-0.2	1.00											
T.A.	0.69	0.39	-0.25	-0.31	1.00										
T.H.	-0.09	-0.5	-0.82	-0.05	0.39	1.00									
Cl.	0.31	-0.13	-0.6	-0.21	0.69	0.61	1.00								
D.O.	-0.67	-0.74	-0.5	0.19	-0.44	0.47	0.03	1.00							
B.O.D.	0.61	0.35	-0.19	-0.16	0.81	0.18	0.59	-0.57	1.00						
C.O.D.	0.41	0.08	-0.48	-0.16	0.8	0.59	0.85	-0.07	0.6	1.00					
NH_4N	0.58	0.19	-0.35	-0.01	0.79	0.57	0.71	-0.15	0.6	0.77	1.00				
Co_2	0.93	0.74	0.32	-0.13	0.69	0.004	0.29	-0.61	0.54	0.41	0.7	1.00			
Po_4	0.77	0.95	0.79	-0.23	0.32	-0.57	-0.25	-0.79	0.36	-0.06	0.16	0.72	1.00		
So_4	0.24	-0.08	-0.58	-0.02	0.6	0.73	0.64	0.32	0.38	0.79	0.79	0.27	-0.18	1.00	
MPN	0.47	0.71	0.71	-0.02	0.03	-0.67	-0.52	-0.65	0.32	-0.35	-0.23	0.37	0.81	-0.39	1.00

Table - 23
Monthly Variation in Abundance of Phytoplakton 2002

Station No - I

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	5	6	8	12	12	11	4	3	5	7	8	4
2	Microshpora	2	3	6	8	8	10	2	2	3	4	5	4
3	Pandorina	4	6	10	12	13	12	6	5	8	9	10	6
4	Pediastrum	10	8	6	10	12	30	-	3	3	9	10	4
5	Ulothrix	20	12	14	16	13	12	-	-	3	5	10	9
6	Spirogyra	22	20	18	19	22	26	6	-	7	9	4	14
7	Zygnema	4	3	1	1	-	-	-	-	2	4	4	3
8	Scenedesmus	7	6	9	7	18	20	9	7	7	9	10	8
9	Volvox	-	2	8	7	14	16	1	-	-	3	3	2
10	Eudorina	1	2	-	-	-	-	2	2	3	6	3	2
	Total	**75**	**68**	**80**	**92**	**112**	**137**	**30**	**22**	**41**	**65**	**67**	**56**

	Becillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	2	4	8	8	6	-	-	2	2	3	2
2	Cyclotella	3	4	6	6	8	8	-	-	2	3	6	4
3	Diotoma	2	3	4	6	12	17	-	-	-	2	2	3
4	Navicula	15	12	10	18	9	1	20	8	1	-	36	20
5	Synebra	1	2	15	19	26	26	1	2	10	13	14	4
6	Nitzschia	16	8	6	5	14	6	1	2	-	10	8	12
7	Melosira	5	4	4	3	-	-	1	2	4	6	4	3
8	Pinnularia	6	6	4	4	-	-	-	1	2	5	4	4
9	Tabellaria	2	2	4	4	6	13	2	1	4	6	2	3
10	Amphipleura	2	2	4	4	6	10	-	-	-	-	2	2
11	Fragilaria	2	4	5	5	7	9	-	-	1	2	3	3
12	Cymbella	-	-	4	5	10	15	-	-	-	-	-	-
	Total	**54**	**49**	**70**	**87**	**106**	**111**	**25**	**16**	**26**	**49**	**84**	**60**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	4	5	6	8	10	1	1	2	2	2	3
2	Microcysits	50	58	46	38	61	68	43	32	20	46	48	40
3	Nostoc	2	2	4	4	6	9	-	-	-	3	3	3
4	Oscillatoria	-	-	-	-	10	25	6	4	2	10	5	2
5	Rivularia	1	2	2	2	4	2	-	-	-	-	-	-
6	Agmenellum	2	2	3	3	4	5	1	1	2	3	3	2
	Total	**59**	**68**	**60**	**53**	**93**	**119**	**51**	**38**	**26**	**64**	**61**	**50**
	Grand Total	**188**	**185**	**210**	**232**	**311**	**367**	**106**	**76**	**93**	**178**	**212**	**166**

Table - 24
Monthly Variation in Abundance of Phytoplakton 2002

Station No - II

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	4	6	7	10	10	12	3	3	4	6	8	4
2	Microshpora	2	2	5	7	8	11	2	2	5	5	6	4
3	Pandorina	4	5	8	12	12	13	6	5	7	9	11	6
4	Pediastrum	10	8	6	8	12	31	-	2	3	7	10	5
5	Ulothrix	19	12	13	16	14	12	-	-	4	6	9	8
6	Spirogyra	20	20	19	19	21	24	5	-	6	8	4	15
7	Zygnema	3	3	1	1	-	-	-	-	2	4	3	3
8	Scenedesmus	6	6	9	9	22	21	8	7	8	9	10	8
9	Volvox	-	3	4	6	12	15	1	-	-	2	3	2
10	Eudorina	1	3	-	-	-	-	2	2	4	5	6	3
	Total	**69**	**68**	**72**	**88**	**111**	**139**	**27**	**21**	**43**	**61**	**70**	**58**

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	Cyclotella	-	2	5	7	7	6	-	-	2	4	4	2
3	Diotoma	4	4	6	6	7	6	-	-	2	3	6	4
4	Navicula	16	14	9	20	9	1	16	10	1	-	36	18
5	Synebra	4	3	16	16	23	24	2	2	12	12	12	13
6	Nitzschia	17	6	6	4	15	6	1	2	10	14	13	14
7	Melosira	5	4	4	2	-	-	-	-	2	6	4	3
8	Pinnularia	6	6	4	6	-	-	-	-	1	2	5	4
9	Tabellaria	2	4	6	7	6	12	6	1	2	4	6	8
10	Amphipleura	4	4	6	6	12	12	-	-	-	-	2	2
11	Fragilaria	2	3	5	6	8	9	-	-	-	2	4	5
12	Cymbella	-	-	4	5	13	13	-	-	-	-	-	-
	Total	**60**	**50**	**71**	**85**	**100**	**89**	**25**	**15**	**32**	**47**	**92**	**73**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	5	6	8	10	12	1	1	2	4	6	7
2	Microcysits	50	56	47	39	60	67	43	32	21	45	48	40
3	Nostoc	2	4	6	7	9	10	-	-	-	2	4	3
4	Oscillatoria	-	-	-	-	12	24	5	4	3	10	6	2
5	Rivularia	1	2	3	3	4	2	-	-	-	-	-	-
6	Agmenellum	2	3	4	5	7	8	8	-	-	2	3	3
	Total	**59**	**70**	**66**	**62**	**102**	**123**	**57**	**37**	**26**	**63**	**67**	**55**
	Grand Total	**188**	**188**	**209**	**235**	**313**	**351**	**109**	**73**	**101**	**171**	**229**	**186**

Table - 25
Monthly Variation in Abundance of Phytoplakton 2002

Station No - III

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	4	6	6	12	12	13	2	1	4	6	6	4
2	Microshpora	2	4	5	6	8	12	3	2	6	5	6	4
3	Pandorina	4	6	8	10	12	12	3	2	8	10	12	10
4	Pediastrum	9	8	6	8	10	28	-	1	3	7	8	4
5	Ulothrix	18	12	13	15	13	12	-	-	3	5	9	8
6	Spirogyra	18	20	22	22	26	24	2	1	4	8	14	16
7	Zygnema	4	4	1	1	-	-	-	-	2	6	6	4
8	Scenedesmus	7	6	8	7	19	20	9	7	6	8	10	7
9	Volvox	-	2	4	7	12	15	4	-	-	2	3	2
10	Eudorina	1	3	-	-	-	-	2	2	4	5	6	3
	Total	**67**	**71**	**73**	**88**	**112**	**136**	**25**	**16**	**40**	**62**	**80**	**62**

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	3	4	6	8	8	2	1	2	4	6	2
2	Cyclotella	4	6	6	8	6	8	1	2	3	6	4	2
3	Diotoma	14	12	11	16	8	2	20	7	1	-	36	20
4	Navicula	4	3	16	15	23	26	2	2	10	12	13	14
5	Synebra	16	8	6	5	14	5	2	2	-	9	8	12
6	Nitzschia	6	6	4	8	10	-	-	-	-	2	6	4
7	Melosira	6	8	9	10	-	-	-	-	2	2	6	7
8	Pinnularia	4	6	7	6	8	10	6	4	5	8	6	6
9	Tabellaria	6	7	6	8	12	14	-	-	-	-	2	3
10	Amphipleura	2	4	5	7	8	8	-	-	-	-	2	4
11	Fragilaria	-	-	3	6	12	17	3	-	-	-	-	-
12	Cymbella	-	-	4	5	13	13	-	-	-	-	-	-
	Total	**62**	**63**	**81**	**100**	**122**	**111**	**36**	**18**	**23**	**43**	**89**	**74**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	6	7	9	10	14	1	2	3	6	6	5
2	Microcysits	50	55	46	32	60	64	42	31	21	44	47	39
3	Nostoc	4	4	8	9	9	12	1	-	-	4	4	4
4	Oscillatoria	-	-	-	-	10	23	5	4	2	10	4	2
5	Rivularia	3	6	7	7	6	9	-	-	-	-	-	-
6	Agmenellum	3	4	7	8	6	10	-	-	-	2	2	4
	Total	**64**	**75**	**75**	**65**	**101**	**132**	**49**	**37**	**26**	**66**	**63**	**54**
	Grand Total	**193**	**209**	**229**	**253**	**335**	**379**	**110**	**71**	**89**	**171**	**232**	**190**

Table - 26
Monthly Variation in Abundance of Phytoplakton 2002

Station No - IV

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	2	5	5	12	12	14	2	1	4	6	5	4
2	Microshpora	2	4	5	6	8	12	1	2	4	5	6	4
3	Pandorina	4	6	7	12	12	14	3	1	8	10	11	6
4	Pediastrum	8	8	5	8	10	26	-	1	2	6	6	4
5	Ulothrix	18	10	13	16	12	12	-	-	3	5	8	7
6	Spirogyra	17	19	24	26	24	25	2	4	6	12	14	10
7	Zygnema	4	6	2	4	-	-	-	-	2	5	6	4
8	Scenedesmus	6	6	8	7	18	20	8	7	6	8	10	7
9	Volvox	-	2	4	7	16	14	4	-	-	2	3	2
10	Eudorina	1	3	-	-	-	-	2	2	4	5	7	3
	Total	**62**	**69**	**73**	**98**	**112**	**137**	**22**	**18**	**39**	**64**	**76**	**51**

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	4	6	6	8	9	2	2	3	5	6	2
2	Cyclotella	3	5	6	8	7	10	2	1	4	6	4	2
3	Diotoma	13	12	11	15	8	2	20	6	1	-	33	19
4	Navicula	3	4	14	16	22	25	2	1	8	12	14	6
5	Synebra	15	7	6	4	14	5	2	2	-	8	8	12
6	Nitzschia	6	8	6	10	-	-	-	-	2	7	3	4
7	Melosira	5	7	9	12	-	-	-	-	2	3	6	4
8	Pinnularia	3	5	8	8	10	10	4	5	9	11	9	7
9	Tabellaria	4	6	7	10	12	13	-	-	-	-	4	3
10	Amphipleura	3	4	5	8	10	12	-	-	-	-	-	2
11	Fragilaria	-	-	2	5	10	16	2	-	-	-	-	-
12	Cymbella	-	-	4	5	13	13	-	-	-	-	-	-
	Total	**55**	**62**	**84**	**107**	**114**	**115**	**34**	**17**	**29**	**52**	**87**	**61**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	6	8	9	10	12	2	1	3	5	5	4
2	Microcysits	50	54	46	30	60	62	40	30	20	43	46	39
3	Nostoc	3	5	6	10	10	12	1	-	-	-	3	5
4	Oscillatoria	-	-	-	-	10	21	4	4	2	10	3	2
5	Rivularia	4	6	7	8	8	12	-	-	-	-	-	-
6	Agmenellum	3	4	6	8	7	10	-	-	-	4	3	4
	Total	**64**	**75**	**73**	**65**	**105**	**129**	**47**	**35**	**25**	**62**	**60**	**54**
	Grand Total	**181**	**206**	**230**	**270**	**331**	**381**	**103**	**70**	**93**	**178**	**223**	**166**

Table - 27
Monthly Variation in Abundance of Phytoplakton 2002

Station No - V

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	2	4	6	10	12	14	2	2	4	5	4	4
2	Microshpora	3	6	8	7	9	11	2	1	3	5	7	4
3	Pandorina	3	5	9	10	13	13	4	2	6	8	9	6
4	Pediastrum	7	8	6	7	10	24	-	1	2	5	6	4
5	Ulothrix	19	10	12	15	12	13	-	-	3	5	9	8
6	Spirogyra	18	20	22	24	24	26	-	1	5	8	9	7
7	Zygnema	4	5	1	1	-	-	-	-	4	4	6	2
8	Scenedesmus	5	6	6	7	18	20	8	7	6	8	10	6
9	Volvox	-	2	5	8	14	16	1	-	-	4	5	3
10	Eudorina	1	3	-	-	-	-	1	2	3	5	6	4
	Total	**62**	**69**	**75**	**89**	**112**	**137**	**18**	**16**	**36**	**57**	**71**	**48**

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	2	4	6	6	8	-	-	1	2	3	2
2	Cyclotella	3	5	6	6	8	8	-	-	2	3	6	3
3	Diotoma	2	3	5	6	12	16	-	-	-	2	4	2
4	Navicula	14	12	10	15	7	3	20	5	1	-	32	18
5	Synebra	2	3	5	18	25	28	2	1	10	12	6	5
6	Nitzschia	14	7	6	4	14	5	2	2	-	8	6	11
7	Melosira	4	5	7	3	-	-	1	2	4	6	4	3
8	Pinnularia	5	6	4	4	-	-	-	1	2	5	3	2
9	Tabellaria	2	4	6	9	11	14	2	1	4	5	3	2
10	Amphipleura	2	2	4	4	7	12	-	-	-	-	2	1
11	Fragilaria	2	4	5	6	8	10	-	-	-	-	1	1
12	Cymbella	-	-	4	6	10	16	-	-	-	-	-	-
	Total	**50**	**53**	**66**	**87**	**108**	**120**	**27**	**12**	**24**	**43**	**70**	**50**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	5	7	9	12	12	1	2	2	2	1	1
2	Microcysits	49	52	46	32	60	61	41	28	20	41	47	38
3	Nostoc	2	4	4	9	12	14	-	-	-	6	6	3
4	Oscillatoria	-	-	-	-	9	21	4	4	1	10	2	2
5	Rivularia	2	2	3	5	6	6	1	2	-	-	-	-
6	Agmenellum	2	3	4	4	6	7	1	2	2	4	3	2
	Total	**59**	**66**	**64**	**59**	**105**	**121**	**48**	**38**	**25**	**63**	**59**	**46**
	Grand Total	**171**	**188**	**205**	**235**	**325**	**378**	**93**	**66**	**85**	**163**	**200**	**144**

Table - 28

Monthly Variation in Abundance of Phytoplakton 2003

Station No - I

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	5	6	8	12	13	13	4	3	5	6	8	4
2	Microshpora	2	4	6	8	8	10	2	1	3	4	6	4
3	Pandorina	4	6	10	13	14	6	5	7	8	9	10	6
4	Pediastrum	11	8	5	10	12	31	-	3	3	8	10	3
5	Ulothrix	19	13	14	15	12	11	-	-	4	5	10	9
6	Spirogyra	20	22	18	19	22	26	6	2	7	9	10	12
7	Zygnema	4	5	2	2	-	-	-	-	2	4	4	3
8	Scenedesmus	7	6	9	6	18	21	9	7	6	9	11	8
9	Volvox	-	-	5	7	14	14	1	-	-	-	1	2
10	Eudorina	1	2	-	-	-	-	1	2	3	6	3	2
	Total	**73**	**72**	**77**	**92**	**113**	**132**	**28**	**25**	**41**	**60**	**73**	**53**

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	3	4	7	6	8	-	-	1	2	4	2
2	Cyclotella	3	4	7	7	8	8	-	-	2	3	6	4
3	Diotoma	2	4	5	6	10	16	-	-	-	2	6	3
4	Navicula	15	13	10	17	9	1	20	8	1	-	36	20
5	Synebra	1	2	14	16	18	24	1	2	12	13	16	6
6	Nitzschia	15	8	7	4	15	6	2	2	-	10	8	12
7	Melosira	4	6	6	3	-	-	-	2	4	6	4	3
8	Pinnularia	6	5	6	-	-	1	3	6	4	5	6	2
9	Tabellaria	2	3	4	6	6	12	2	1	4	6	6	1
10	Amphipleura	2	2	5	6	6	10	-	-	-	-	3	2
11	Fragilaria	2	4	5	5	7	9	-	-	1	2	4	3
12	Cymbella	-	-	4	6	10	16	-	-	-	-	-	-
	Total	**52**	**54**	**77**	**83**	**95**	**111**	**28**	**21**	**29**	**49**	**99**	**58**

	Cynophyceae	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec
1	Anabaena	4	5	6	6	8	12	1	1	2	3	4	3
2	Microcysits	52	57	46	39	61	68	43	32	19	45	49	41
3	Nostoc	2	3	4	4	7	9	-	-	-	2	3	2
4	Oscillatoria	-	-	-	-	10	24	6	5	2	10	6	2
5	Rivularia	1	2	4	4	6	6	-	-	-	-	-	-
6	Agmenellum	1	2	3	4	4	6	1	1	2	3	3	2
	Total	**60**	**69**	**63**	**57**	**96**	**125**	**51**	**39**	**25**	**63**	**65**	**50**
	Grand Total	**185**	**195**	**217**	**232**	**304**	**368**	**107**	**85**	**95**	**172**	**237**	**161**

Table - 29
Monthly Variation in Abundance of Phytoplakton 2003

Station No - II

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	3	5	7	11	12	10	2	1	4	6	7	4
2	Microshpora	2	2	5	7	10	12	2	1	5	6	6	4
3	Pandorina	4	4	6	13	14	16	4	5	7	9	10	6
4	Pediastrum	10	8	6	8	12	31	-	2	4	7	10	5
5	Ulothrix	20	11	13	15	15	12	-	-	4	6	10	8
6	Spirogyra	20	22	18	20	21	24	2	2	4	8	9	6
7	Zygnema	3	2	1	1	-	-	-	-	2	4	3	2
8	Scenedesmus	6	6	8	9	22	21	8	7	8	9	10	8
9	Volvox	-	2	4	10	12	16	4	-	-	2	3	6
10	Eudorina	2	4	-	-	-	-	2	4	5	6	7	3
	Total	**70**	**66**	**68**	**94**	**118**	**142**	**24**	**22**	**43**	**63**	**75**	**52**

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	1	2	6	7	7	8	-	-	2	4	2
2	Cyclotella	4	4	7	7	6	7	1	2	2	3	6	4
3	Diotoma	16	15	9	20	9	1	16	10	2	-	36	18
4	Navicula	3	3	15	16	22	26	10	2	12	10	12	4
5	Synebra	17	6	6	5	15	5	1	2	10	13	13	14
6	Nitzschia	4	5	5	2	-	-	-	-	2	6	4	3
7	Melosira	6	7	8	9	-	-	-	-	2	3	4	6
8	Pinnularia	2	4	6	8	6	7	4	2	2	4	6	4
9	Tabellaria	4	4	7	7	12	12	-	-	-	-	3	2
10	Amphipleura	2	3	6	8	9	-	-	-	2	4	5	6
11	Fragilaria	-	-	4	6	12	14	-	-	-	-	-	-
12	Cymbella	-	-	4	6	12	14	-	-	-	-	-	-
	Total	**58**	**52**	**79**	**100**	**110**	**93**	**40**	**18**	**34**	**45**	**93**	**63**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	4	6	8	10	12	1	2	2	6	8	6
2	Microcysits	50	55	46	40	60	68	43	32	22	46	48	40
3	Nostoc	2	4	5	6	9	12	-	-	-	2	6	3
4	Oscillatoria	-	-	-	-	13	24	5	4	3	10	6	1
5	Rivularia	1	2	4	4	6	-	-	-	-	-	-	-
6	Agmenellum	2	4	6	7	8	10	3	4	6	6	8	2
	Total	**59**	**69**	**67**	**65**	**106**	**126**	**52**	**42**	**33**	**70**	**76**	**52**
	Grand Total	**187**	**187**	**214**	**259**	**334**	**361**	**116**	**82**	**110**	**178**	**244**	**167**

Table - 30
Monthly Variation in Abundance of Phytoplakton 2003

Station No - III

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	4	5	7	10	12	14	2	1	4	5	7	5
2	Microshpora	2	3	6	9	13	14	1	1	5	4	6	3
3	Pandorina	3	5	9	12	12	12	1	-	6	6	7	4
4	Pediastrum	9	8	6	7	11	29	-	2	3	7	8	4
5	Ulothrix	17	13	13	15	13	12	-	-	3	5	8	8
6	Spirogyra	16	22	22	25	26	26	2	-	8	10	12	10
7	Zygnema	3	4	2	1	-	-	-	-	2	5	6	4
8	Scenedesmus	6	6	9	7	19	20	9	7	6	8	10	6
9	Volvox	-	2	4	7	13	16	4	-	-	2	3	2
10	Eudorina	1	4	-	-	-	-	3	2	4	5	7	3
	Total	**61**	**72**	**78**	**93**	**119**	**143**	**22**	**13**	**41**	**57**	**74**	**49**

	Becillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	3	6	6	9	10	2	1	3	4	5	2
2	Cyclotella	3	5	5	8	10	8	1	2	4	4	6	3
3	Diotoma	15	12	11	17	9	2	20	6	1	-	37	20
4	Navicula	3	4	10	15	22	24	2	1	10	13	13	10
5	Synebra	17	8	6	5	14	5	2	2	-	8	8	12
6	Nitzschia	3	6	4	8	12	-	-	-	-	2	6	3
7	Melosira	3	9	10	10	-	-	-	-	2	2	5	3
8	Pinnularia	2	5	10	10	-	-	-	-	2	4	6	5
9	Tabellaria	5	7	8	10	12	16	-	-	-	-	3	3
10	Amphipleura	-	3	6	8	8	-	-	-	-	-	2	3
11	Fragilaria	3	-	3	5	12	16	3	-	-	-	-	-
12	Cymbella	-	-	4	6	12	14	-	-	-	-	-	-
	Total	**54**	**62**	**83**	**108**	**120**	**95**	**30**	**12**	**22**	**37**	**91**	**64**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	3	5	7	10	14	1	2	4	5	6	6	4
2	Microcysits	50	55	46	32	60	64	43	31	20	44	46	40
3	Nostoc	4	4	6	10	10	12	1	-	-	3	4	4
4	Oscillatoria	-	-	-	-	9	23	4	4	2	10	3	2
5	Rivularia	2	8	9	9	12	4	-	-	-	-	-	-
6	Agmenellum	2	6	8	8	10	12	-	-	-	3	2	2
	Total	**61**	**78**	**76**	**69**	**115**	**116**	**50**	**39**	**27**	**66**	**61**	**52**
	Grand Total	**176**	**212**	**237**	**270**	**354**	**354**	**102**	**64**	**90**	**160**	**226**	**165**

Table - 31

Monthly Variation in Abundance of Phytoplakton 2003

Station No - IV

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	4	5	8	14	14	16	2	1	4	7	8	5
2	Microshpora	3	5	6	8	10	12	3	3	5	6	7	4
3	Pandorina	3	7	7	14	14	14	2	2	6	8	10	6
4	Pediastrum	9	8	6	8	10	26	-	2	2	7	6	4
5	Ulothrix	18	9	13	15	12	13	-	-	3	6	8	7
6	Spirogyra	16	18	22	25	24	26	2	1	5	10	12	8
7	Zygnema	3	5	7	62	-	-	-	-	2	5	7	4
8	Scenedesmus	6	6	7	7	18	20	7	7	6	8	10	6
9	Volvox	-	2	3	8	12	16	12	4	-	-	2	3
10	Eudorina	1	2	-	-	-	1	2	4	5	6	7	5
	Total	63	67	79	161	114	144	30	24	38	63	77	52

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	3	6	8	10	12	2	2	7	5	6	3
2	Cyclotella	2	5	6	8	8	10	2	1	4	6	3	2
3	Diotoma	13	13	11	15	7	2	20	7	1	-	33	19
4	Navicula	4	6	12	15	20	22	2	2	6	10	14	6
5	Synebra	15	6	6	4	14	5	2	2	-	8	8	12
6	Nitzschia	5	8	9	9	-	-	-	-	2	6	4	3
7	Melosira	4	7	10	10	6	-	-	-	3	4	4	2
8	Pinnularia	5	4	7	8	12	11	3	2	8	11	11	6
9	Tabellaria	3	6	8	10	14	-	-	-	-	-	4	3
10	Amphipleura	2	5	6	10	14	-	-	-	-	-	5	4
11	Fragilaria	-	-	4	6	12	18	2	1	-	-	-	-
12	Cymbella	-	-	4	6	12	14	-	-	-	-	-	-
	Total	**53**	**63**	**89**	**109**	**129**	**94**	**33**	**17**	**31**	**50**	**92**	**60**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	4	10	10	12	11	11	1	2	4	6	5	3
2	Microcysits	50	54	45	30	60	62	40	30	20	43	46	40
3	Nostoc	3	7	8	10	12	12	1	-	-	2	3	2
4	Oscillatoria	-	-	-	-	10	21	5	4	2	10	3	2
5	Rivularia	5	7	8	8	12	14	-	-	-	-	-	-
6	Agmenellum	4	6	8	9	12	-	-	-	6	4	3	2
	Total	**66**	**84**	**79**	**69**	**117**	**120**	**47**	**36**	**32**	**65**	**60**	**49**
	Grand Total	**182**	**214**	**247**	**339**	**360**	**358**	**110**	**77**	**101**	**178**	**229**	**161**

Table - 32
Monthly Variation in Abundance of Phytoplakton 2003

Station No - V

	Chlorophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Chlorella	1	3	5	9	10	12	1	1	3	3	4	3
2	Microshpora	2	5	6	6	9	10	2	1	4	5	6	5
3	Pandorina	4	5	9	10	10	12	2	2	6	9	8	4
4	Pediastrum	7	8	6	7	10	24	-	1	2	5	6	4
5	Ulothrix	13	15	16	19	13	11	-	-	4	8	11	11
6	Spirogyra	16	18	20	22	22	24	2	-	4	8	8	6
7	Zygnema	3	5	1	1	-	-	-	-	3	4	6	3
8	Scenedesmus	6	6	8	7	18	20	8	7	6	8	10	6
9	Volvox	-	2	4	6	8	12	3	2	-	-	3	4
10	Eudorina	2	3	-	-	-	-	1	2	3	4	4	6
	Total	54	70	75	87	100	125	19	16	35	54	66	52

	Bacillariophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Astorionella	-	2	3	5	5	8	-	-	1	3	2	3
2	Cyclotella	2	4	5	4	6	-	-	2	2	5	6	4
3	Diotoma	2	3	4	6	10	14	-	-	-	2	3	1
4	Navicula	14	12	10	15	7	3	20	5	1	-	32	18
5	Synebra	2	3	4	16	22	26	2	1	10	10	12	6
6	Nitzschia	15	7	6	4	14	5	2	2	-	8	6	11
7	Melosira	4	3	5	6	3	-	-	-	-	4	5	4
8	Pinnularia	4	6	4	3	-	-	-	1	1	2	3	3
9	Tabellaria	2	3	5	9	10	12	1	2	5	4	3	2
10	Amphipleura	2	3	4	4	6	10	-	-	-	-	2	1
11	Fragilaria	2	4	6	6	8	10	-	-	-	-	2	2
12	Cymbella	-	-	4	5	10	15	-	-	-	-	-	-
	Total	**49**	**50**	**60**	**83**	**101**	**103**	**25**	**13**	**20**	**38**	**76**	**55**

	Cynophyceae	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Anabaena	3	4	6	8	12	16	1	2	3	3	1	1
2	Microcysits	49	52	46	32	60	61	41	28	20	41	46	35
3	Nostoc	2	4	5	6	10	16	-	-	-	5	5	3
4	Oscillatoria	-	-	-	-	8	21	4	3	1	10	3	2
5	Rivularia	2	2	4	5	6	7	2	2	-	-	-	-
6	Agmenellum	2	4	4	6	6	8	1	1	2	3	3	2
	Total	**58**	**66**	**65**	**57**	**102**	**129**	**49**	**36**	**26**	**62**	**58**	**43**
	Grand Total	**161**	**186**	**200**	**227**	**303**	**357**	**93**	**65**	**81**	**154**	**200**	**150**

Table - 33

Monthly Variation in Abundance of Zooplankton

Station No - I												2002	
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	1	2	4	5	7	9	1	1	2	2	3	2
2	Paramecium	3	3	5	6	8	12	1	1	3	4	5	2
3	Metopus	-	-	-	2	4	6	-	-	-	-	-	-
4	Vorticella	1	2	3	4	6	10	-	-	-	2	2	1
5	Euglypha	1	1	2	3	4	6	-	-	1	1	-	-
6	Euglena	1	6	12	15	16	18	-	-	2	4	6	-
7	Acanthocystis	4	8	8	13	16	18	-	-	2	4	6	3
	Total	**11**	**22**	**34**	**48**	**61**	**79**	**2**	**2**	**10**	**17**	**22**	**8**
	Rotifera												
1	Asplanchna	3	6	16	19	18	20	1	-	8	14	16	2
2	Brachionus	18	6	10	16	20	21	3	1	5	8	14	15
3	filinia	-	3	2	1	6	4	2	2	3	10	1	-
4	Keratella	-	-	-	-	-	6	4	4	2	14	2	-
5	Philodina	2	6	6	10	12	15	2	2	4	6	5	4
	Total	**23**	**21**	**34**	**46**	**56**	**66**	**12**	**9**	**22**	**52**	**38**	**21**
	Crustacea												
	a-Cladocera												
1	Alona	1	2	2	4	6	8	1	1	2	4	4	2
2	Moina	5	10	13	24	22	14	4	3	1	3	5	2
3	Daphnia	7	20	26	32	47	9	-	-	-	10	10	12
4	Ceriodaphnia	1	2	8	6	6	6	-	-	1	2	2	1
5	Oxyurella	2	8	9	10	12	8	6	2	3	4	6	5
	Total	**16**	**42**	**58**	**76**	**93**	**45**	**11**	**6**	**7**	**23**	**27**	**22**
	b-Copepoda												
1	Cyclops	5	6	7	25	30	20	22	4	5	14	32	35
2	Mesocyclops	-	-	-	10	6	4	-	-	4	16	14	-
3	Allodiaptomos	6	8	6	12	12	4	3	3	5	8	9	6
4	Macrocyclops	7	6	9	10	12	16	4	3	7	8	10	7
5	Ergasilus	4	2	2	4	3	2	-	-	2	4	6	6
	Total	**22**	**22**	**24**	**61**	**63**	**46**	**29**	**10**	**23**	**50**	**71**	**54**
	Grand Total	**72**	**107**	**150**	**231**	**273**	**236**	**54**	**27**	**62**	**142**	**158**	**105**

Table - 34
Monthly Variation in Abundance of Zooplankton

Station No - II													2002
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	2	2	4	6	7	9	2	1	2	2	3	2
2	Paramecium	3	4	4	5	7	11	2	2	3	5	5	2
3	Metopus	-	-	-	3	6	6	-	-	-	-	-	-
4	Vorticella	2	2	4	6	7	12	-	-	-	-	2	2
5	Euglypha	1	2	4	4	5	6	-	-	2	3	-	-
6	Euglena	1	6	13	15	17	19	-	-	3	6	6	-
7	Acanthocystis	3	7	7	12	14	15	18	16	6	3	7	3
	Total	**12**	**23**	**36**	**51**	**63**	**78**	**22**	**19**	**16**	**19**	**23**	**9**
	Rotifera												
1	Asplanchna	4	10	16	21	22	22	3	2	8	12	16	3
2	Brachionus	17	6	11	15	20	22	3	1	4	8	14	16
3	filinia	-	3	2	2	6	4	2	2	3	10	1	-
4	Keratella	-	-	-	-	-	7	4	3	2	15	2	-
5	Philodina	4	5	5	10	14	16	2	1	4	6	4	4
	Total	**25**	**24**	**34**	**48**	**62**	**71**	**14**	**9**	**21**	**51**	**37**	**23**
	Crustacea												
	a-Cladocera												
1	Alona	2	2	5	5	8	1	1	3	5	5	6	3
2	Moina	6	9	12	24	22	15	3	3	1	3	5	2
3	Daphnia	6	21	25	38	49	6	-	-	-	6	15	12
4	Ceriodaphnia	2	2	7	8	8	9	-	-	1	3	4	3
5	Oxyurella	3	6	10	10	10	12	3	2	4	6	5	3
	Total	**19**	**40**	**59**	**85**	**97**	**43**	**7**	**8**	**11**	**23**	**35**	**23**
	b-Copepoda												
1	Cyclops	6	5	7	26	30	19	22	4	4	15	32	33
2	Mesocyclops	-	-	-	10	5	4	-	-	3	16	13	-
3	Allodiaptomos	6	7	8	9	12	6	4	4	6	8	6	4
4	Macrocyclops	6	6	9	12	12	14	4	4	6	8	10	6
5	Ergasilus	5	3	3	4	3	2	-	-	2	5	7	6
	Total	**23**	**21**	**27**	**61**	**62**	**45**	**30**	**12**	**21**	**52**	**68**	**49**
	Grand Total	**79**	**108**	**156**	**245**	**284**	**237**	**73**	**48**	**69**	**145**	**163**	**104**

Table - 35
Monthly Variation in Abundance of Zooplankton

Station No - III		2002											
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	3	3	5	5	7	10	2	1	3	2	3	2
2	Paramecium	2	3	4	8	10	12	1	2	2	4	4	3
3	Metopus	-	-	-	4	7	6	-	-	-	-	-	-
4	Vorticella	2	3	5	6	6	10	-	-	-	-	2	3
5	Euglypha	1	3	4	4	6	8	-	-	2	3	-	-
6	Euglena	2	5	10	12	14	18	-	-	2	4	8	5
7	Acanthocystis	2	6	6	10	14	16	18	16	5	4	6	5
	Total	**12**	**23**	**34**	**49**	**64**	**80**	**21**	**19**	**14**	**17**	**23**	**18**
	Rotifera												
1	Asplanchna	4	10	16	22	25	25	2	6	10	14	15	6
2	Brachionus	15	5	10	15	20	21	2	1	5	8	15	15
3	fielinia	5	6	12	14	16	18	18	-	-	6	9	5
4	Keratella	2	4	6	10	14	15	2	3	5	8	7	6
5	Philodina	4	5	5	12	14	15	2	2	4	6	4	4
	Total	**30**	**30**	**49**	**73**	**89**	**94**	**26**	**12**	**24**	**42**	**50**	**36**
	Crustacea												
	a-Cladocera												
1	Alona	3	3	6	6	6	3	2	1	4	3	6	2
2	Moina	2	2	3	4	6	6	2	1	2	4	5	3
3	Daphnia	6	20	25	33	47	6	-	-	-	10	9	13
4	Ceriodaphnia	3	3	9	9	10	12	-	-	2	2	4	3
5	Oxyurella	2	4	10	10	12	12	3	2	5	5	6	4
	Total	**16**	**32**	**53**	**62**	**81**	**39**	**7**	**4**	**13**	**24**	**30**	**25**
	b-Copepoda												
1	Cyclops	5	5	7	26	30	19	21	4	4	15	31	34
2	Mesocyclops	-	-	-	9	6	4	-	-	4	17	15	-
3	Allodiaptomos	5	8	9	9	10	9	3	2	17	8	5	4
4	Macrocyclops	5	5	10	10	10	12	3	3	6	6	8	4
5	Ergasilus	4	3	4	4	3	2	-	-	3	6	8	4
	Total	**19**	**21**	**30**	**58**	**59**	**46**	**27**	**9**	**34**	**52**	**67**	**46**
	Grand Total	**77**	**106**	**166**	**242**	**293**	**259**	**81**	**44**	**85**	**135**	**170**	**125**

Table - 36
Monthly Variation in Abundance of Zooplankton

Station No - IV													2002
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	3	4	6	6	8	11	2	1	4	6	6	3
2	Paramecium	2	4	5	9	10	10	2	1	3	5	6	4
3	Metopus	-	-	-	4	6	6	-	-	-	-	-	-
4	Vorticella	3	3	6	6	7	11	-	-	-	-	-	-
5	Euglypha	2	3	4	6	6	8	-	-	3	2	-	-
6	Euglena	3	6	10	13	16	19	-	-	3	4	5	4
7	Acanthocystis	2	4	5	8	10	14	12	16	6	8	8	4
	Total	**15**	**24**	**36**	**52**	**63**	**79**	**16**	**18**	**19**	**25**	**25**	**15**
	Rotifera												
1	Asplanchna	3	6	16	20	26	28	3	3	10	15	16	7
2	Brachionus	15	6	11	17	19	22	3	1	4	8	14	14
3	filinia	-	3	2	2	6	3	2	2	3	9	1	-
4	Keratella	-	-	-	-	-	6	4	5	2	15	2	-
5	Philodina	3	5	6	13	16	18	4	3	5	7	9	3
	Total	**21**	**20**	**35**	**52**	**67**	**77**	**16**	**14**	**24**	**54**	**42**	**24**
	Crustacea												
	a-Cladocera												
1	Alona	2	3	4	8	7	3	2	1	3	4	6	3
2	Moina	5	10	12	24	22	14	4	3	1	3	5	3
3	Daphnia	7	20	25	32	47	9	-	-	-	10	10	11
4	Ceriodaphnia	2	2	8	10	12	12	-	-	2	4	4	2
5	Oxyurella	3	4	7	9	10	14	3	1	6	6	7	3
	Total	**19**	**39**	**56**	**83**	**98**	**52**	**9**	**5**	**12**	**27**	**32**	**22**
	b-Copepoda												
1	Cyclops	4	6	8	24	30	18	22	4	6	13	31	35
2	Mesocyclops	-	-	-	10	7	4	-	-	4	14	15	-
3	Allodiaptomos	4	9	10	11	12	12	3	2	6	7	4	3
4	Macrocyclops	4	6	9	12	13	14	2	1	5	6	8	2
5	Ergasilus	3	4	5	4	8	2	-	-	4	6	9	5
	Total	**15**	**25**	**32**	**61**	**70**	**50**	**27**	**7**	**25**	**46**	**67**	**45**
	Grand Total	**70**	**108**	**159**	**248**	**298**	**258**	**68**	**44**	**80**	**152**	**166**	**106**

Table - 37
Monthly Variation in Abundance of Zooplankton

Station No - V													2002
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	2	3	6	6	9	12	1	1	3	5	6	4
2	Paramecium	3	5	7	8	12	12	2	1	4	6	6	3
3	Metopus	-	-	-	4	8	8	-	-	-	-	-	-
4	Vorticella	2	3	5	7	10	12	-	-	-	-	-	-
5	Euglypha	4	4	6	6	6	8	-	-	4	4	-	-
6	Euglena	3	5	8	12	14	18	-	-	2	5	6	3
7	Acanthocystis	2	3	4	8	12	16	17	10	14	5	8	7
	Total	**16**	**23**	**36**	**51**	**71**	**86**	**20**	**12**	**27**	**25**	**26**	**17**
	Rotifera												
1	Asplanchna	3	7	14	18	22	25	26	2	4	8	14	6
2	Brachionus	16	6	10	16	20	20	2	1	4	6	12	13
3	filinia	-	3	2	1	6	6	2	2	3	9	1	-
4	Keratella	-	-	-	-	-	6	3	4	2	14	2	-
5	Philodina	2	4	6	10	16	16	4	3	6	7	8	4
	Total	**21**	**20**	**32**	**45**	**64**	**73**	**37**	**12**	**19**	**44**	**37**	**23**
	Crustacea												
	a-Cladocera												
1	Alona	2	4	8	8	6	3	2	1	4	4	7	3
2	Moina	5	10	13	23	21	14	3	3	1	3	5	2
3	Daphnia												
4	Ceriodaphnia	7	26	25	30	47	8	-	-	-	9	9	14
5	Oxyurella	3	4	8	10	13	13	-	-	2	4	5	2
	Total	2	5	8	10	12	14	2	1	6	7	7	3
	b-Copepoda												
1	Cyclops	4	5	9	23	30	20	21	4	5	14	34	35
2	Mesocyclops	-	-	-	10	5	4	-	-	5	16	14	-
3	Allodiaptomos	3	6	9	10	13	12	2	1	5	6	7	4
4	Macrocyclops	2	5	9	10	14	13	2	1	4	3	6	4
5	Ergasilus	4	3	6	6	8	7	2	1	3	6	6	3
	Total	**13**	**19**	**33**	**59**	**70**	**56**	**27**	**7**	**22**	**45**	**67**	**46**
	Grand Total	**52**	**67**	**109**	**165**	**217**	**229**	**86**	**32**	**74**	**121**	**137**	**89**

Table - 38
Monthly Variation in Abundance of Zooplankton

Station No - I												2003	
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	1	3	4	5	8	9	1	1	2	3	3	2
2	Paramecium	3	4	5	6	8	13	1	1	3	5	6	3
3	Metopus	-	-	-	2	5	6	-	-	-	-	-	-
4	Vorticella	1	2	4	5	6	10	-	-	-	2	2	1
5	Euglypha	1	1	2	3	5	6	-	-	1	1	-	-
6	Euglena	2	6	13	16	17	18	-	-	2	4	6	3
7	Acanthocystis	4	8	9	13	17	18	-	-	2	3	6	4
	Total	**12**	**24**	**37**	**50**	**66**	**80**	**2**	**2**	**10**	**18**	**23**	**13**
	Rotifera												
1	Asplanchna	3	5	17	19	18	20	-	-	7	15	16	2
2	Brachionus	18	5	10	16	20	20	3	1	5	8	13	15
3	filinia	-	3	12	2	6	4	2	2	3	10	1	-
4	Keratella	-	-	-	-	-	6	4	3	2	14	2	-
5	Philodina	2	5	6	11	12	14	3	2	4	6	5	4
	Total	**23**	**18**	**45**	**48**	**56**	**64**	**12**	**8**	**21**	**53**	**37**	**21**
	Crustacea												
	a-Cladocera												
1	Alona	1	2	2	4	6	8	1	1	2	3	4	2
2	Moina	6	10	12	24	21	15	4	2	1	3	5	2
3	Daphnia	8	20	25	31	48	9	-	-	-	9	10	12
4	Ceriodaphnia	1	2	8	6	7	6	-	-	1	2	2	1
5	Oxyurella	2	8	10	10	12	7	6	2	3	4	6	5
	Total	**18**	**42**	**57**	**75**	**94**	**45**	**11**	**5**	**7**	**21**	**27**	**22**
	b-Copepoda												
1	Cyclops	5	6	8	25	30	19	23	4	5	14	33	35
2	Mesocyclops	-	-	-	10	8	4	-	-	5	16	15	-
3	Allodiaptomos	6	8	6	10	11	5	3	3	5	8	9	6
4	Macrocyclops	7	6	9	10	12	16	4	3	7	8	10	7
5	Ergasilus	4	2	2	4	3	2	-	-	2	4	6	6
	Total	**22**	**22**	**25**	**59**	**64**	**46**	**30**	**10**	**24**	**50**	**73**	**54**
	Grand Total	**75**	**106**	**164**	**232**	**280**	**235**	**55**	**25**	**62**	**142**	**160**	**110**

Table - 39
Monthly Variation in Abundance of Zooplankton

Station No - II													2003
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	2	2	5	6	7	9	2	1	2	2	3	2
2	Paramecium	3	4	4	5	7	11	2	2	3	5	5	2
3	Metopus	-	-	-	3	6	6	-	-	-	-	-	-
4	Vorticella	2	2	4	6	7	12	-	-	-	-	2	2
5	Euglypha	1	2	4	4	5	6	-	-	2	3	-	-
6	Euglena	1	5	14	15	17	20	-	-	3	7	6	-
7	Acanthocystis	3	7	7	12	14	15	19	15	6	3	8	2
	Total	**12**	**22**	**38**	**51**	**63**	**79**	**23**	**18**	**16**	**20**	**24**	**8**
	Rotifera												
1	Asplanchna	4	10	16	20	22	23	3	2	9	12	15	3
2	Brachionus	16	6	11	15	20	22	3	1	3	8	13	16
3	fielinia	-	3	2	2	6	3	2	2	3	10	1	-
4	Keratella	-	-	-	-	-	6	5	3	2	14	2	-
5	Philodina	4	5	6	10	15	17	2	1	3	5	4	4
	Total	**24**	**24**	**35**	**47**	**63**	**71**	**15**	**9**	**20**	**49**	**35**	**23**
	Crustacea												
	a-Cladocera												
1	Alona	2	3	4	5	8	1	1	3	5	5	6	3
2	Moina	5	9	12	23	22	15	3	2	1	3	5	2
3	Daphnia	5	22	24	37	50	5	-	-	-	5	15	13
4	Ceriodaphnia	2	2	7	8	8	10	-	-	1	3	4	3
5	Oxyurella	3	6	10	10	11	12	3	2	4	6	5	3
	Total	**17**	**42**	**57**	**83**	**99**	**43**	**7**	**7**	**11**	**22**	**35**	**24**
	b-Copepoda												
1	Cyclops	5	5	7	26	31	19	22	4	5	15	32	34
2	Mesocyclops	-	-	-	10	5	4	-	-	3	15	13	-
3	Allodiaptomos	6	7	8	9	12	6	4	4	6	7	6	4
4	Macrocyclops	6	6	9	12	12	14	4	4	6	8	10	6
5	Ergasilus	5	3	3	4	3	2	-	-	2	5	7	6
	Total	**22**	**21**	**27**	**61**	**63**	**45**	**30**	**12**	**22**	**50**	**68**	**50**
	Grand Total	**75**	**109**	**157**	**242**	**288**	**238**	**75**	**46**	**69**	**141**	**162**	**105**

Table - 40
Monthly Variation in Abundance of Zooplankton

Station No - III		2003											
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	3	3	5	6	8	10	2	1	3	2	3	2
2	Paramecium	2	3	4	8	11	12	1	2	2	4	4	3
3	Metopus	-	-	-	4	7	6	-	-	-	-	-	-
4	Vorticella	2	3	5	6	7	10	-	-	-	-	1	3
5	Euglypha	1	3	4	4	6	8	-	-	2	3	-	-
6	Euglena	2	5	10	12	15	18	-	-	2	4	8	5
7	Acanthocystis	2	6	7	10	13	16	17	16	5	4	6	5
	Total	**12**	**23**	**35**	**50**	**67**	**80**	**20**	**19**	**14**	**17**	**22**	**18**
	Rotifera												
1	Asplanchna	4	10	16	23	25	25	2	6	10	13	15	5
2	Brachionus	14	5	10	16	20	22	2	1	5	8	15	15
3	filinia	5	6	12	14	17	17	18	-	-	6	9	14
4	Keratella	2	4	6	10	14	15	2	3	5	8	7	5
5	Philodina	4	5	5	12	14	15	2	2	4	6	5	4
	Total	**29**	**30**	**49**	**75**	**90**	**94**	**26**	**12**	**24**	**41**	**51**	**43**
	Crustacea												
	a-Cladocera												
1	Alona	3	3	4	6	6	3	2	1	4	3	6	2
2	Moina	2	1	3	4	6	6	2	1	2	4	5	3
3	Daphnia	7	20	24	32	47	5	-	-	-	10	9	13
4	Ceriodaphnia	3	3	8	9	10	12	-	-	2	2	4	3
5	Oxyurella	2	4	8	10	13	11	3	2	5	5	6	4
	Total	**17**	**31**	**47**	**61**	**82**	**37**	**7**	**4**	**13**	**24**	**30**	**25**
	b-Copepoda												
1	Cyclops	5	6	7	26	31	18	20	5	4	16	29	33
2	Mesocyclops	-	-	-	9	5	4	-	-	4	16	16	
3	Aliodiaptomos	5	8	8	9	10	9	3	2	7	8	5	4
4	Macrocyclops	5	5	8	10	10	12	3	3	6	7	8	4
5	Ergasilus	4	3	3	4	3	2	-	-	3	6	8	5
	Total	**19**	**22**	**26**	**58**	**59**	**45**	**26**	**10**	**24**	**53**	**66**	**46**
	Grand Total	**77**	**106**	**157**	**244**	**298**	**256**	**79**	**45**	**75**	**135**	**169**	**132**

Table - 41
Monthly Variation in Abundance of Zooplankton

Station No - IV		2003											
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	2	3	6	7	9	11	2	1	3	5	7	3
2	Paramecium	2	4	6	9	10	10	2	1	2	5	7	4
3	Metopus	-	-	-	4	6	6	-	-	-	-	-	-
4	Vorticella	2	3	6	6	8	11	-	-	-	-	-	-
5	Euglypha	2	3	4	6	6	9	-	-	3	2	-	-
6	Euglena	3	6	11	12	17	19	-	-	3	4	5	4
7	Acanthocystis	2	4	6	8	10	15	12	15	6	8	8	1
	Total	**13**	**23**	**39**	**52**	**66**	**81**	**16**	**17**	**17**	**24**	**27**	**12**
	Rotifera												
1	Asplanchna	3	6	16	20	27	28	3	3	10	16	15	7
2	Brachionus	14	6	10	17	18	23	4	2	3	7	13	14
3	filinia	-	2	2	3	6	3	2	2	4	9	1	-
4	Keratella	-	-	-	-	-	5	4	5	3	15	2	-
5	Philodina	3	5	6	13	17	18	4	3	6	8	9	3
	Total	**20**	**19**	**34**	**53**	**68**	**77**	**17**	**15**	**26**	**55**	**40**	**24**
	Crustacea												
	a-Cladocera												
1	Alona	2	3	4	8	7	3	2	1	3	4	7	3
2	Moina	6	10	12	24	23	13	5	3	1	2	5	3
3	Daphnia	6	22	25	32	46	9	-	-	-	10	9	11
4	Ceriodaphnia	2	2	8	10	12	12	-	-	2	4	4	2
5	Oxyurella	3	4	7	9	10	14	3	1	6	6	7	3
	Total	**19**	**41**	**56**	**83**	**98**	**51**	**10**	**5**	**12**	**26**	**32**	**22**
	b-Copepoda												
1	Cyclops	5	6	8	24	30	18	22	4	6	13	31	35
2	Mesocyclops	-	-	-	9	7	4	-	-	5	14	16	-
3	Allodiaptomos	4	9	10	11	13	12	3	2	6	7	4	3
4	Macrocyclops	4	6	10	12	13	14	2	1	5	6	8	2
5	Ergasilus	3	4	5	4	3	2	-	-	4	7	9	5
	Total	**16**	**25**	**33**	**60**	**66**	**50**	**27**	**7**	**26**	**47**	**68**	**45**
	Grand Total	**68**	**108**	**162**	**248**	**298**	**259**	**70**	**44**	**81**	**152**	**167**	**103**

Table - 42
Monthly Variation in Abundance of Zooplankton

Station No - V												2003	
	Protozoa	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Arcella spp.	2	3	5	6	9	12	1	1	4	5	6	4
2	Paramecium	3	4	7	8	12	11	2	1	4	6	5	3
3	Metopus	-	-	-	4	8	8	-	-	-	-	-	-
4	Vorticella	2	3	5	7	10	11	-	-	-	-	-	-
5	Euglypha	4	4	6	6	7	8	-	-	4	4	-	-
6	Euglena	3	5	8	12	14	18	-	-	2	5	6	3
7	Acanthocystis	2	3	4	8	12	17	17	10	14	5	8	7
	Total	**16**	**22**	**35**	**51**	**72**	**85**	**20**	**12**	**28**	**25**	**25**	**17**
	Rotifera												
1	Asplanchna	3	7	14	18	22	25	26	2	4	8	14	6
2	Brachionus	15	5	10	17	19	20	1	1	4	6	12	13
3	fielinia	-	2	2	1	6	5	2	2	3	9	1	-
4	Keratella	-	-	-	-	-	5	3	4	2	14	2	-
5	Philodina	2	4	6	10	16	16	4	3	6	7	8	4
	Total	**20**	**18**	**32**	**46**	**63**	**71**	**36**	**12**	**19**	**44**	**37**	**23**
	Crustacea												
	a-Cladocera												
1	Alona	2	4	8	8	6	3	2	1	4	5	7	3
2	Moina	6	10	13	23	20	13	3	3	1	3	5	2
3	Daphnia	6	21	22	30	47	7	-	-	-	8	9	14
4	Ceriodaphnia	3	4	8	10	13	14	-	-	2	4	5	2
5	Oxyurella	2	5	8	10	12	14	2	1	6	7	8	3
	Total	**19**	**44**	**59**	**81**	**98**	**51**	**7**	**5**	**13**	**27**	**34**	**24**
	b-Copepoda												
1	Cyclops	4	5	9	23	31	20	21	4	5	13	34	35
2	Mesocyclops	-	-	-	9	5	4	-	-	5	15	14	-
3	Allodiaptomos	3	6	9	10	12	12	2	1	5	6	7	4
4	Macrocyclops	2	5	9	10	14	13	2	1	4	3	6	4
5	Ergasilus	4	3	6	6	9	7	2	1	3	6	6	3
	Total	**13**	**19**	**33**	**58**	**71**	**56**	**27**	**7**	**22**	**43**	**67**	**46**
	Grand Total	**68**	**103**	**159**	**236**	**304**	**263**	**90**	**36**	**82**	**139**	**163**	**110**

iii Biological Factors

Under these MPN, plankton, aquatic weeds and fishes were investigated during in the period of two years study (January 2002 to December 2003).

PLANKTON

(A) _Phytoplankton

In the present observation only dominant groups of phytoplankton were studied quantitatively and qualitatively and identified upto genus which are –

i- **Chlorophyceae** - It comprises 10 genera in qualitative study the under mentioned genera were observed

(1) Chlorella (2) Microspora (3) Pandorina (4) Pediastrum

(5) Ulothrix (6) Spirogyra (7) Zygnema (8) Scenedesmus

(9) Volvox (10) Eudorina.

Quantitative observation

Group chlorophyceae varied from 16 org/l to 139 org/l during the period of 2002 and 2003 varied from 16 org/l to 161 org/l. (Table23to32)

ii-Bacillariophyceae - mainly 12 genera were observed qualititavely.

(1) Asterionella (2) Cyclotella (3) Diatoma (4) Navicula

(5) Synedra (6) Nitzshia (7) Melosira (8) Pinnularia

(9) Tabellaria (10) Amphipleura (11) Fragilaria (12) Cymbella

Quantitative observation

Group Bacillariophyceae varied from 12 org/l to 120 org/l during the period of 2002 and in 2003 varied from 12 org/l to 117org/l (Table23to32)

iii- Myxophyceae - It consisted mainly 6 genera i.e.

(1) Anabaena (2) Microcysits (3) Nostoc (4) Oscillatoria
(5) Rivularia (6) Agmenellum

Quantitative observation

Group Myxophyceae varied from 25 to 132 org/l during the period of 2002 and in 2003 ranged from 25 org/l to 129 org/l. (Table~~23 to 32~~)

The populations of phytoplankton has been presented in tables.

(B) _Zooplankton

The zooplankton population mainly consisted of Protozoans, Rotifers and Crustaceans, in the present investigation. Only dominant group of Zooplankton were studied qualitatively and quantitatively and identified upto genus as follows –

Group (a) Protozoa – Mainly 7 genera i.e.

(1) Arcella (2) Paramecium (3) Metopus (4) Vorticella
(5) Euglypha (6) Euglena (7) Acanthocystis

Quantitative investigation

Group protozoa varied from 2 org/l to 86 org/l during the period of 2002 and in 2003 ranged from 2 org/l to 85 org/l. (Table~~33 to 42~~)

Group (b) Rotifera – Mainly 5 genera i.e.

(1) Asplanchna (2) Brachionus (3) Fielinia
(4) Keratella (5) Philodina

Quantitative investigation

Group Rotifera ranged from 9 org/l to 89 org/l during the period of 2002 and varied in 2003 from 8 org/l to 94 org/l. (Table~~33 to 42~~)

Group (c) Crustacea –

i- **Cladocera**- Mainly 5 genera i.e.

(1) Alona (2) Moina (3) Daphnia

(4) Ceriodaphnia (5) Oxyurella

Quantitative investigation

Sub group Cladocera varied from 4 org/l to 99 org/l during the period of 2002 and in 2003 ranged from 4 org/l to 99 org/l. (Table 33 to 42)

ii- **Copepoda**- Mainly 5 genera i.e.

(1) Cyclops (2) Mesocyclops (3) Allodiaptomos

(4) Macrocyclops (5) Ergasilus

Quantitative investigation

This sub group ranged from 7 org/l to 71 org/l during the period of 2002 and in 2003 varied from 7 org/l to 73 org/l. (Table 33 to 42)

Aquatic Weeds

The various forms of the aquatic weeds were observed during both the years of study from different five stations of the river Ken they are :-

S.No.	Name of Species of weeds	Types of weeds*
1.	Nypheaea stellata	F.F.
2.	Trapa bispinosa	F.F.
3.	Nymphoides cristatum	F.L.
4.	Ceratophyllum demersum	S.
5.	Hydrilla verticillata	S.
6.	Nechamandra altemifolia	S.
7.	Vallisneria spiralis	S.
8.	Ottelia alismoides	S.
9.	Eichhornia crassipes	F.F.

10.	Spirodella polyrhiza	F.F.
11.	Lemna paucicostata	F.F.
12.	Potamogeton indicus	S/F.L.
13.	Potamogeton pectinatus	S.
14.	Potamogeton crispus	S.
15.	Potamogeton perfoliatus	S.
16.	Najas minor	S.
17.	Chara Spp.	S.
18.	Nitella Spp.	S.
19.	Marselia quadrifolia	F.F.
20.	Azolla Spp.	F.F.

* F.F. = free floating weeds, F.L.= floating level weeds, S.= Submerged weeds

Fishes

Occurance of economically important fishes is ristricted due to the ecological and hydrological features of the river. Bigger forms are frequent in deep and rapid waters almost throught the year, but the shallow waters are completely devoid of these forms due to intense fishing. Besides, the fish fauna is characteristic in having both plain and hill stream fishes. Natural habitats of the fishes are continuously disturbed due to the sand excavations at Banda, Khaptiha, Pailani and Chilla in Yamua by artificial and natural means. A systematic list of identified fishes of the Ken river is given as under:-

Classified List of Fishes in Ken River

Species	Local Name
Family-clupeidae	
1. Gadusia chapra (Ham.)	Suhiya
Family-Notopteridae	
1. Notopterus notopterus	Patara

2. Notopterus Chitala — Moya

Family-Cyprimdae

Sub. F. Abramidinae

1. Oxygaster bacaila — Chelhwa

Sub. F. Rasborinae

1. Barilius barila
2. Barilius bola — Ghilra
3. Rasvora daniconius
4. Catla catla — Catla, Bosa or Bhakur
5. Chagunius chagunio — Chhagua
6. Cirrhinus mrigala — Nain or Bajia
7. Cirrhinus reba — Raiya or Lahkariya
8. Esomus danricus — Anjara
9. Garoa gotyla — (Hill stream)
10. Labeo bata — Bata
11. Labeo calbasu — Karaunt
12. Labeo gonius — Khursa
13. Labeo rohita — Rohu
14. Puntius sarana — Putiyah or Khabda
15. Tor putitora — Mahaseer

Family Cobitidae

16. Noemacheilus botia — (Hill stream)

Sub family cobitini

17. Lepidocephalichthyes guntea — (Hill stream)

Family Siluridae

18. Wallago attu — Parhrin or lanchi

Family Bagaridae

19. Mystus aor — Tengan
20. Mystus seenghala — Seenghala or Tengan

21.	Mystus tengera	Katua
22.	Rita rita	Gigra
Family Schilbeidae		
23.	Eutropiichthys vacha	Bachuwa
Family Saccobranchidae		
24.	Heteropneustes fossilis	Singhi
Family Clariidae		
25.	Clarias batrachus	Mangur
Family Belonidae		
26.	Xenentodon cancila	Sua
Family Ophiocephalidae		
27.	Channa gachua	Bilaua or Girai
28.	Channa marulius	Padamsaur
29.	Channa puntatus	Sauri
Family Centropomidae		
30.	Chanda nama	Chanda
31.	Chanda ranga	Chanda
Family Nandidae		
32.	Nandus nandus	
Family Mastacembilidae		
33.	Mastacembelus armatus	Bam

DISCUSSION

DISCUSSION

In India the rivers are the means of transport, recreation, power generation and a treasure house of natural resource of water supply for drinking, irrigation and fish production. They are holy divine and are also closely associated with culture and heritage.

The rapid increasing industrialization and population of the country is causing a great threat to these rivers by changing their natural nature due to heavy discharge of factory chemical effluents, sewage, solid municipal wastes. They are changing the natural nature of rivers' water due to heavy pollution Now-a-days these rivers have been badly effected obviously the entire biota, drinking water quality and other human activities are being adversely influenced.

Therefore it is very essential at present to study the different aspects by which these rivers have been badly effected and loosing their natural nature.

Having in view these problems the river Ken is studied by taking their physical, chemical & Biological characteristics considering required parameters for every aspect. Besides, the meteorological conditions also studied have direct impact on aquatic life. Data as regards atmospheric temperature, rainfall, relative humidity, photo-period are studied and monthly mean is calculated.

Measures are also suggested for the management of this river, so that its natural nature might be maintained, which will really be fruitful. Regarding this the river Ken was studied for the period of two years (Jan.2002 to Dec. 2003).

METEOROLOGICAL CONDITIONS

Atmospheric Temperature

The atmospheric temp. directly effected the water temp. High atmospheric temp. increase the water temperature and vice-versa . Minimum atmospheric temperature 8.87^0c was found in the month of January and maximum 41.3^0c in April in 2002, and in 2003 the maximum atmospheric temperature 41.45^0c was found in June and minimum 6.31^0c in the month of January. So the atmospheric temperature is directly related to water temperature and influenced the river water temperature which affects the primary productivity of biota of river. It showed positive relationship with photoperiod whereas relative humidity impacts negatively.

Rainfall

The rainfall enhances the turbidity of river water due to silting and decomposition of organic matters in rainy season. It was high during monsoon period 248.32mm in the month of August and minimum in winter season 1 mm in the month of December. Due to high rainfall as turbidity increases which affected adversely on photosynthetic activity in river water, which decreases the concentration of Dissolved Oxygen (D.O.) with the result productivity of water becomes low.

Relative Humidity

It is negatively related with atmospheric temperature and positively with rainfall. It increased in monsoon period in the month of August in 2002 and 2003 whereas it decreases in summer season in the month of June both the year due to cloudy weather and rains, which has negative impact on photosynthetic activities and also adversely effect the biology of aquatic biota.

Photoperiod

Photoperiod was found maximum in summer season and minimum in winter season. In the year 2002 it was maximum 13.34 Hrs. in the month of June and minimum10.16 Hrs. in January, whereas in 2003 it was maximum 13.16 Hrs. in the month of July and minimum 10.07 Hrs. in January month. Photosynthesis is directly related to photoperiod, which increase the concentration of oxygen. High photoperiod was due to high intensity of solar radiation.

Physico-chemical and Biological Characteristics

For the assessment of river water Physico-chemical and Biological parameters are taken in which-

Physical- Water temperature, Water current, Turbidity.

Chemical- pH (Hydrogen-ion-concentration), Total alkalinity, Total hardness, Chloride, Dissolved oxygen, Bio-chemical oxygen demand (B.O.D.), Chemical oxygen demand (C.O.D.), Ammonical nitrogen, Carbon-di-oxide, Phosphate and Sulphate.

Biological- Total Coliform (MPN), Plankton (Phyto and Zoo), Aquatic weeds and Fish funa.

Physical Factors

Water Temperature - Temperature is one of the most important factor. In the present study of tropical region aquatic biota which determine the physico-chemical characteristics of the river water. As the river is shallower than Yamuna therefore the impact of the physical factors like photo-period, humidity, water current, turbidity more than the water. It is also influenced by the ingress of feeder stream. Odum and Wilson (1962) reported that if the transparency of

the water is reduced by reduction of light availability, it would adversely effect the temperature of water and thus the primary production decreases due to lack of photosynthetic activity.

During the present study of Ken river water temperature varied between 17.29^0c to 31.32^0c in the year 2002 and between 14.27^0c to 31.28^0c in 2003, at different sampling stations. The mean value of water temperature in study period of 2002 is 24.42 to 25.45 and between 24.06^0c to 24.32^0c in the year of 2003 ranged from different sampling stations. The lowest temperature of water was recorded during winter season (Jan) while the highest temperature was noticed in summer season (June) in both the years. Amongst all sampling stations (I to V) the water temperature was found to be comparatively higher at station I and station III due to low water level, sewage pollution and great insulation from the sun. The observation are resemble to the findings of Vashisth and Sra (1979), Rishi (1983), Tiwari (1981), Upadhya et.al.(1982), Kudesia et. al. (1985), Mathur et. al. (1987), Bhatnagar (1989), Malviya (1990), Singh et. al. (1995), Shukla (1996), Updhayay (1997), Saxena (1998) and Singh et. al. (1999). Higher water temperature at polluted stations may be attributed to a lot of chemical activity due to discharge of huge quantity of municipal and sewage wastes into the river.

Discharge of sewage from municipal drains in the river stretch resulted in depletion of Dissolved oxygen, growth of Blue green algae and put stress on fish and aquatic life. Besides affacting biota, high temperature sharply decreases the solubility of oxygen in water. At higher temperature microbial activity increases which in turn leads to higher oxygen consumption leading to a consequent decrease dissolved oxygen content of water and cause asphyxiation on fishes and it may be fatal, this results occasional fish mortality (Jhingaran, 1991).

Temperature affacts the quality of water as potable and recreational water. Besides, this it also affacts the permeability of cytoplasm, metabolic rates and reproductive ability of the aquatic biota. Temperature measurments are useful in indicating the levels of chemical, biological and bio-chemical activities alongwith saturation values of solids and gases present in water.

In the present study, the river water temperature showed significant positive correlation with total alkalinity and negative correlation with Dissolved oxygen.

Temperature is one of the determining factors in the seasonal concentrations of planktonic organisms (Allen, 1920; Chandler, 1944; Jackson and Meir, 1965). Regarding the role of temperature in regulating the seasonal abundance of different groups of Zooplankton, varying statement have been put forward, Byars (1960) reported that the temperature had the greatest influence on the productivity of Rotifers. Ganapati and Rao (1954) and Chen (1965) have mentioned that the seasonal variations in the density of copepods were influenced by temperature. The Rotifers showed preference for lower temperature and were abundent in November through they were also in good numbers in the month of June due to considerable quantity of diatoms and Blue green algae. The copepods showed similar pattern through with strength greater thermal variations and were abundent in September and November during present investigations. This work is confirmity with Saha (1985), Srinivasan (1974), Soha and Patrick (1986) and Singhal et. al. (1996).

Turbidity

Turbidity, transparancy, colour are closely interrelated and effect the river biota. Turbidity is transparancy in natural water and majourly caused by rains, floods, wind velocity and also clay, silt, organic matter, phytoplankton and other

microscopic organisms, domestic wastes and sewage drains. It also depend of nature of basin. Turbidity adversely effects the productivity of biota due to interference in light penetration, which plays a great role in photosynthetic activity. Jhingaran (1991) reported that the fish fertility in very highly turbid water is badly effected alongwith its flora and fauna.

Turbid water unfit for domestic purposes, food and many other industrial uses and interferes with the self purification of streams and river by reducing the photosynthetic activity of water plants and by smoothing benthic organisms. Turbidity previously had been measured in J.T.U. (Jackson Turbidity Unit) but recently N.T.U. (Nephlometeric Turbidity Unit) is used estimated by Nephlometer. 5 N.T.U. is the optimum recommended by W.H.O. for drinking water whereas Indian standared permit upto 10 N.T.U. in the absence of any alternative source.

In the present study the turbidity of river water ranged from 24.0 to 77.0 N.T.U. during the first year in 2002, and 25.0 to 78.0 N.T.U. in the second year (2003). The highest value of turbidity 78.0 N.T.U. was recorded at station-IV in August 2002. The higher value was in summer due to silting, high wind velocity whereas in monsoon, contamination of organic matter through surface run-off. The mean value of turbidity during the study period ranging from 48.66 to 49.50 N.T.U. during both the years of study.

Various suspended particles reduce Dissolved Oxygen in water due to ill effects of photosynthetic activity. Wilson (1959) reported that it hampers the spawning and growth of fishes due to lack of oxygen availability. Jhingaran (1991) investigated that the suspended particles adsorb considerable amount of nutrient elements like Phosphates, Potassium and Nitrogen in the ionic forms making them unavailable for plankton production.

Kulsherstha et. al. (1989) studied biology of certain river and reported the turbidity in the range of 20 to 2600 N.T.U. Varughese (1991) studied hydrology of river Narmada and reported that turbidity was nil at most of the stations except in rainy months. Murugesan et. al. (1994) assessed the water quality of river Tamprapani and reported the turbidity between 5.0 N.T.U. to 20.0 N.T.U. Krishnamuthy and Bharati (1994) studied the turbidity between 2.7 to 35.5 N.T.U. in Kalindi. Baruah et. al. (1995) and Kataria et. al. (1995) reported the turbidity between 2.3 to 84.4 N.T.U. and 10.00 to 21.0 N.T.O. in Jhanji river and Ajnar river respectively, Kataria et. al. (1996) studied the turbidity between 8.0 to 40 N.T.U. of Tawa reservoir.

All the workers unanimous and concluded that terbidity of the flood waters reduced the Plankton density. Pahwa and Malhotra (1966) reported that turbidity not only adversely effect the primary productivity but also destructs the plankters. The observations of the present study are in similar with other studies done by Malviya (1990), Upadhyay (1997), Saxena (1976) and Raju et. al. (1999). Turbidity showed positive correlation with total alkalinity at all places which obstruct light penetration and adversely affacts the phtosynthetic activities.

Water Current

It is one of the important factors which has a direct relationship with the turbidity. In present study the current of river ranged 5.3Cum./Sec. to 1000.9Cum./Sec. during both the years (2002-2003) of study.

The highest value of water current 1000.9Cum./Sec. was recorded at Station No.-I in August, 2002 and the second year in 2003, this highest value

recorded at station -I, III and IV in the month of August, September and August respectivily. The variation are due to flood in span of the river.

The slow water flow in summer enhances the organic materials. This expresses that the reduction in the water swiftness promotes the better niche for the Plankton community.

The main feature of influx significance of the river is the silt laden water flow which was recorded maximum during the mansoon period because of the high flood. During the summer the river almost changed into a slow spill channel like a trickling stream, due to the less rainfall conditions. Water current showed positive correlation with turbidity, at all the station.

Obviously water current is plays a great role and fertility as well as production of fishes. This resumble with Mitra (1968) work that span could not struggle against high current to 0.4Km./Hrs.

Chemical Factors

Hydrogen-ion concentration (pH) -

The Hydrogen ion concentration of natural water is an important chemical factor by which the nature of water is determined which place very essential role for biota water is dissociated in to H^+ and OH^- ions, the product of which at any time is a constant Kω. equalling approximately 10^{-14} moles/Litre. The pH of water is defined as the logarithm of the reciprocal of hydrogen ion concentration. It indicates the acidic or alkaline nature of water. pH in natural water depend upon the amount of carbonates, bicarbonates and carbon-di-oxide tension. The later is effected by photosynthesis of aquatic vegetation and respiration of animals.

In the present study pH of river water ranged from 7.49 to 8.20 with a mean value of 7.80 to 8.80 in both the years of study period. Minimum pH value was noticed at station-II and maximum at station-I. Higher pH value in summer was due to the utilization of free carbon-di-oxide during active photosynthesis and minimum value was recorded during winter season due to dissociation of carbonic acid (H_2CO_3). At station-I, II, III and IV pH value should minor variation whereas (station-V) has major in comperision to other stations difference due to more organic materials and drainage through Nala from Chilla town. Besides it is a confluence point were this Ken river joins the river Yamuna at this station. Hence the water is more alkaline there. The impact of pH values which causes water either acidic or alkaline. So the quality of water has great impact on the fertility in this medium.

As per the data recorded in the present investigation the water at station-V had more fish and plankton density besides the weeds were also recorded, more than those of other four station- I, II, III and IV. Swingle (1967) observed that water having a pH of 6.5 to 9.0 are most suitable for fish culture and those having pH values of more than 9.5 is unsuitable because in the later carbonate is not available whereas fishes die at about pH 11.

Present investigation resembles with the above work. Similar findings have been recorded by others as Laxminaryana (1965), Devid (1966) and Tiwari (1983) reported that pH has positive correlation with total alkalinity.

Total Alkalinity (T.H.)

The alkalinity of water is its quantitative capacity to neutralize a strong acid to a designated pH. Total Alkalinity is the buffering capacity of water. It refers for the quantity and kind of dissolved compounds present which

collectively shift the pH to the side of normality. The alkalinity of natural water in due to the salt of weak acid, weak or strong bases, free hydroxyl ion and hydrolysis of salts. All cations with weak base (bicarbonates, carbonates, organic acid) and hydroxyl ions belong to these substances.

Alkalinity measurements are also important in controlling water and waste water treatment process. The alkalinity value is quite important in caculating the dose of alum and biocides in water. It is producing substances such as sodium-bi-carbonets are added to check corrosion in soft water supplies. The productivity of water depend upon the total alkalinity which as positive correlation with pH.

In the present study the value of total alkalinity varied from 120 to 173ppm. The mean value of 120 to 172.5ppm. was found in both the years. The minimum value of alkalinity was found during winter season (January) at station-III, IV and V in both the years due to water infested with aquatic plants and low pH. The high value of total alkalinity was observed during summer season due to low level of water, concentration of carbonets alongwith high decomposition of organic matter at station-I in June.

The alkalinity of water as little public health significance it is not hermmful to human beings but it beyond 200ppm. causes unpleasent teste to the water. BIS has set desirable level of alkalinity in drinking water and domestic use to be 100ppm. whereas its permissible limit is 300ppm. in the absence of any alternative source.

The trend of alkalinity value showed significant variations on seasonal and interstational basis, signifying that the river receives the substance at station-I, by the mixing of city sewage and at station-V, nala, drains from Chilla town in other stations domestic sewages discharged in the river.

The present finding are in conformity with the observations made by other researchers such as Raina et. al. (1984), Mishra et. al. (1990), Ramana et. al. (1994), Mitra (1997) and Pande & Sharma (1999).

Total Hardness (T.H.)

Hardness of water is an important factor in determining the suitability of a water for domestic uses as well as for the development of its biota. So the hardness is frequently used as an assessment of the quality of water. It is governed mainly by the contents of calcium and magnisium. The hardness in water is derived largely from contact with the soil and rocks. In general hard waters are found in areas were the top soil is thick and limestone formations are present whereas soft water are seen in areas where the top soil is thin and limestones formation are absent.

In the present study the value of hardness in the river water varied from 80 to 162ppm. during both the years of study period (2002-2003) and the mean value of hardness ranged from 120 to 172.5ppm. The minimum value of hardness observed at station-V in the month of August during both the years due to more dilution of water, less evaporation, exchange of sodium ions and concentration of calcium is reduced at higher pH due to its precipitations as calcium carbonate. The maximum value of hardness was found at station-I in June both of the years due to joins of sewage nala of city Banda. The findings of hardness in river water reveles that water was comparatively hard at station-I and II, than other stations.

The significant variations were found in summer and post monsoon period, whereas it was higher to some extent at station-III and IV. This variation is due to the more rocks formations at station-I & II, less at station-III & IV and absent at station-V and anthropogenic activities of the holy fairs arranged there.

The W.H.O. has set its desirable limit to be 100ppm. according to limit of W.H.O. the water is soft and above from this range it was hard. The present findings resemble with the observation of Raina et. al. (1984) found total hardness between 80.6 to 203.6ppm. in river Jhelum, Ajamal et. al. (1985) found higher value of hardness recorded during summer in the study of river Kalindi.

Chloride (Cl)

The chloride is very important factor of water, their concentration changes when physico-chemical and biological process take place in water. It is present in appreciable amount in almost all natural waters. The chloride content normally increases as the mineral content increases. The most important sources of chloride in the water is disposal of domestic sewage. Its limit for water to be used as drinking purpose has been set to be 250 ppm by BIS. Its above range of chloride water become salty taste and effect the palatability of water.

Human and animal excreta have high quantity of chlorides along with notrogenous compounds. Since chloride is set to be accompanied with faeces. Hence increase in chloride concentration serves as one of the signals of faecal pollution.

In the present study chloride concentration was found in the range of 12.00 to 49.00ppm. In the year 2002 it ranged 14.00 to 49.00ppm while in the year 2003 between 12.00 to 49.00ppm. at different stations. The mean value of chloride during the study period of 2002 varied from 33.00 to 33.50 ppm and in 2003 ranged from 32.00 to 33.75 ppm at different monitoring stations. The highest concentration was observed at station-I and II in May during both the years. due to addition of domestic waste, sewage and municipal wastes in to the

river. Higher value of chloride also recorded at station-IV due to washing, bathing and other extraneous sources. The lowest value of chloride was observed at station-III in August, 2003 due to intrance of plenty of water and dilution effect in rainy season.

During the occasion sudden increase in value of chloride was recorded at station-I, II, III and IV in the month of November, January and March due to pilgrims activities on Kartik Poornima, Makar Shankranti and Maha Shivratri fair and animal excreta increases the faecal pollution in the river water.

According to Verma and Shukla (1978) the maximum chloride is notable during the period of maximum growth of phytoplankton, Zooplankton and bottom biota. The present study of chloride showed correlation with water temperature, ammonical nitrogen whereas directly related with phytoplankton and zooplankton densities. Sahai and Sinha (1969) reported a direct correlation between chloride and water temperature, phyto & zooplankton growth and bottom biota.

Dissolved Oxygen (D.O.)

It is one of the most important parameter in water assessment. It is essential to the production and support of biological life in the water. Oxygen is consumed by the respiration of plants and animals, bacterial decomposition of organic matter and as well as the chemical oxidation of waste substances. It also plays an important role in the organic cycle of river water. The main source of oxygen in water is from the atmosphere. Oxygen is dissolved in to the upper layers of the water body through the air water interface and is dispersed through out the water body by wind and wave action, vertical mixing and other forms of agitation.

Most of the critical conditions related to dissolved oxygen deficiency occur during the summer season. This directly influence the biomagnification and bioaccumulation of the river ecology.

In the present investigation the river water showed good Dissolved oxygen value varying from 6.74 to 8.93ppm. in the year 2002 and between 6.75 to 8.93ppm. in 2003 at different sampling stations. The mean value of Dissolved oxygen during the study period 7.79 to 7.89ppm. the highest value of D.O. was observed during winter season due to low temperature, and much water quantity whereas lowest value recorded in summer season in the month of June due to high temperature and low water level which decreases the oxygen holding capacity of water.

The dominance of Zooplankton over phytoplankton is responsible for depletion of oxygen, the respiratory demand of the relatively more dominant of Zooplankton the presence of pollutants discharge by the various drains, are the contributory limiting factors for the low or nil dissolved oxygen values. The concentration of D.O. is also effected by the contamination of animal excreta. Its measurement provides a valuable clue to the metabolic balance of a water body.

The water quality criteria according to C.B.P.C.W.P. (1985) suggest minimum level of Dissolved oxygen upto 5ppm. is suitable for drinking purpose. The present work is in confirmity with the findings of Sinha et. al. (1995) who reported Dissolved oxygen in the range of 5.18ppm. in summer and 12.9ppm. in winter season in the river Sai at Raebareli. Sharma and Agrawal (1999) studied Yamuna river and registered D.O. concentration in the 6.7 to 9.5ppm.. The significant negative correlation of D.O. with temperature, Co_2 and B.O.D. was observed during investigation period.

The trend of Dissolved oxygen value showed variation on seasonal and interstational basis. D.O. values mostly similar at station-I, II, III and IV whereas

at station-V the value of D.O. found much rather than other stations due to much quantity of water, deepness and confluence of the river.

Biochemical Oxygen Demand (B.O.D.)

The Biochemical Oxygen Demand is the amount of oxygen required by bacteria and other microbes while stabilizing the decomposable organic matter under aerobic conditions. It is an empirical test to determine the relative oxygen requirements of waste waters, effluents and polluted waters. It gives an idea about the external pollution and governs the need for, the degree of dilution. It has a relationship with nitrogen too, as it gives an impression of the total quantity of organic matter and the B.O.D. shows the requirements of the quantity which is capable to be decomposed.

In the present study the value of the B.O.D. in the river water varied from 1.00 to 2.50ppm. in the year 2002 and between 1.00 to 2.40 ppm in 2003 at different sampling stations. The mean value of B.O.D. during the study period was 1.73 to 1.82ppm.. The maximum value of B.O.D. was noticed in June 2002 at station-I and II due to city sewage, waste pollution and high temperature whereas minimum value of B.O.D. of observed in September at station-V because of more dilution of water and self reoxygenation process during the course of its flow upto last station and also due to low temperature. B.O.D. showed significant positive correlation with temperature most of the time. The present work is resemble to the Venkata et. al. (1995) who observed the permissible limit varied from 0.4 to 2.6ppm. and Rajkumari (1999) studied the B.O.D. in the range of 1.1 to 14.0ppm.

Chemical Oxygen Demand (C.O.D.)

The chemical oxygen demand is the measure of organic matter which estimate the carbonaceous factors of organic matter. It is based on the fact that

all the carbonaceous matters can be oxidized to carbon-di-oxide and water, regardless of the biological assimilability of the substance by strong oxidising agents in the acidic range. The C.O.D. test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances.

In the present investigations C.O.D. value varied from 6.40 to 13.90ppm. in the year 2002 and between 6.30 to 14.00ppm. in 2003 at different sampling stations during the study period. The mean value of C.O.D. during the study period of in 2002 varied from 9.59 to 9.56ppm. and in 2003 it ranged from 9.35 to 9.55ppm. at different sampling stations. The desirable limit of C.O.D. is 10ppm. in drinking water as recommended by W.H.O.. During the investigation the highest value was observed in summer season at station-I and II due to high temperature, low water level and much organic concentration whereas lowest value was in rainy season due to dilution of water, low temperature and less density of organic matters.

The C.O.D. showed positive correlation with B.O.D., temperature and the load of organic matters at most of the stations. B.O.D. and C.O.D. are the indicator of water quality.

Present findings are conformity with Sivasubramanam et. al. (1995) who reported that C.O.D. value fluctuated according to seasonal changes.

Ammoniacal Nitrogen (NH_4-N)

The most important inorganic nitrogen compounds in water are nitrate and ammonia, both are important sources of nitrogen for aquatic plant life. The most important source of ammonia is the ammonifiction of organic matter. Organic and nitrogenous matter is decayed by microbiological activity with the production of ammonia. Nitrogen compounds serve as nutrients for aquatic

microorganisms and responsible for the eutrophication of river water. High concentration of this facter is found in water, polluted by sewage either directly ammoina or ammonium salts. Sewage has large quantities of nitrogenous matter, thus its disposal tends to increase the ammonia content of the wastes. Occurrence of ammonia in the water can be accepted as the chemical evidence of organic pollution, which convert into nitrite the nitrate.

The presence of only ammonia in the water indicates the sewage pollution recently and occurence of nitrite with ammonia shows time has been lapsed since the pollution has occured. If all the nitrogen is present in nitrate from a long time has been passed after pollution because water becomes purified itself and all nitrogenous matter are beings oxidized. Ammonia in higher concentration is harmful to fish and other biota. It is also toxic to man at higher concentrations. A level of 0.15ppm. of free ammonia has been recommended by BIS for fish culture.

In the present study ammonical nitrogen concentration varied between 0.01 to 0.12ppm. in the year of 2002 and ranged from 0.01 to 0.13ppm. in 2003 at different sampling stations. The mean value of ammonical nitrogen during the study period of 2002 varied from 0.03 to 0.04ppm. and in 2003 varied from 0.04 to 0.05ppm. at different sampling stations. The maximum concentration of ammonical nitrogen was observed in summer season in the month of June due to much decomposition of organic matter, animal excreta, high alkalinity and high temperature whereas minimum concentration was noticed in the month of August due to dilution of organic matter by rain water. Hutchinson (1957) investigated that summer maxima of ammonia concentration was also observed in May and June. Hence in the present study the findings of the above works resemble with work of Hutchinson.

The present findings are also in confirmity with observation made by other researchers such as Chauhan et. al. (1990) determine the ammonical nitrogen in the range from 0.02 to 1.00ppm. in Narmada river and Joi et. al. (1990) studied the Periyar rivers who reported the ammonical nitrogen in range of 0.03 to 0.65ppm. it showed positive correlation with temperature and total alkalinity at most of the stations. The value of ammonical nitrogen varied from station to station. The highest value was found at station-II and V and other station-I, III, IV mostly more or less similar to one another. Highest value was found at station-I due to decomposition of organic matter and at station-V due to nala discharge and animal excreta.

Carbon-di-oxide (CO_2)

Carbon di oxide in natural water is derived from the atmosphere, respiration of animals and plants in night, bacterial decomposition of organic matter, seeping ground water and combination with other substance chiefly calcium and magnesium in water. During day time, carbon-di-oxide is lesser due to its utilization in photosynthesis. While during night time it is greater because it is given off as a result of respiration by aquatic organisms. It is highly soluble in water. The presence or absence of the free carbon dioxide in the surface water in mostly governed by its utilization by algae during photosynthesis also through is diffusion from air (Sreenivasan 1974). The absence of free carbon-di-oxide is explained on the basis that either it is completely utilised by the phytoplankton or it is converted into carbonic acid finally into stable carbonates. The high Co_2 contents appears to be more toxic in the presence of low oxygen contents (Welch 1952). Hutchinson (1957) explained that the study of carbon-di-oxide is quite important to understand the hydrogen-ion concentration of water.

In the present study carbon dioxide concentration ranged from 1.6 to 4.6ppm. in the year 2002 and between 1.5 to 4.7ppm. in 2003 at different sampling stations. The mean value of Co_2 during the study period of 2002 varied from 2.8 to 2.97ppm. and in 2003 ranged from 2.84 to 3.04ppm at different sampling stations. The highest value of Co_2 was observed in summer season in the month of June at station-I and II due to nala sewage high decomposition of organic matter animal excreta at high temperature and respiration of living organisms whereas lowest value of Co_2 recorded in winter season in the month of January at station-V due to low decomposition of organic matter, low temperature and much water quantity. The concentration of carbon-di-oxide showed an inverse relationship with dissolved oxygen and pH value, while significant positive correlation with water temperature and C.O.D. in the present investigation.

Phosphate (Po_4)

Phosphorus is an essential and major nutrient for plant growth and responsible for biological productivity. It is associated with the eutrophication problem of water bodies. In unpolluted water bodies, phosphate are formed mainly during certain biological process of transformation of organic substances to inorganic phosphate. During the vegetation period, the phosphates are soluble form are readily taken up by aquatic plant, organisms, mainly phytoplanktons. Considerable irregular increases in the concentration of phosphate indicates the presence of pollutants. Agricultural run-off, dead micro organisms domestic sewage, synthetic detergents and waste water are the major sources of phosphorus in aquatic habitats, which enter in the water body in significant amount along with the run-off water from the

catchment area. The later source contributes approximately 100% phosphate in domestic wastes. Phosphates are found in all photoautotrophs where they are synthesized enzymatically and constitute part of phosphate pool. It is the primary vehicle for distribution of metabolic energy through functioning of A.T.P.

Most of the workers Laxminarayan (1965), Venkateswarlu (1969), Raj gopalan et. al. (1973), Verma et. al. (1984), Shaw et. al. (1991) reported high phosphate concentration at polluted and sewage contaminate stations of the rivers as compared to unpolluted ones, Accumulation of phosphate in winter may be attributed to its formation, accumulation and addition through sewage and agricultural drainage due to its lesser and slower utilization in photosynthetic activity.

The prime concern of phosphates lies in the ability to increase the growth of nuisance algae and eutrophication. Although phosphate is not considered as harmful constituents in drinking water but its presence in even small amount can produced accelarated growth of algae and aquatic vegetation, there by causing eutrophication of the aquatic system. Though BIS or USEPA have not set any standerd value for phosphate in drinking water but owing to the above discussed importance, this parameter was also monitored.

In the present study the level of phosphate content was recorded between 0.17 to 0.56ppm. in the year 2002 and in 2003 varied from 0.17 to 0.57ppm. at different sampling stations. The maximum concentration was observed at station-I and II in August 2003 due to agricultural run-off and sewage which cause eutrophication whereas minimum concentration was noticed at station-IV and V due to lack of discharge. At the station-III and IV some higher concentration of

phosphate was found due to discharge of domestic wastes and sewage. The mean value of phosphate during study period of 2002-2003 was found in the range of 0.12 to 0.31ppm. from different sampling stations.

The present findings are in conformity with the work of Pande and Sharma (1999) who found phosphate in the range of 0.5 to 0.85ppm. in sediments of river Ramganga at Moradabad. Phosphate showed positive correlation with total alkalinity at most of the monitoring stations.

Sulphate (So_4)

Sulphate is an important constituent of hardness with calcium and magnesium and impart permanent hardness to the water. Sulphate content of natural water is an important consideration in determining their suitability for public and industrial supply because of its cathartic effect upon human when it is present in excessive amounts but at higher concentration it causes gastro-intestinal irritation when sodium or magnesium is present.

It is a naturally occurring an ion in all kinds of natural water. It is found in arid and semiarid regions, particularly in higher concentration due to the accumulation of soluble salts in soil. The supply of sulphate ions in surface, ground and under ground water, under natural conditions is due to the reaction of water with sulphate containing rocks. It is also due to the bio-chemical and chemical oxidation of sulphide and other compounds of sulphur.

Sulphate determination in polluted water, sewage and industrial effluents are of paramount importance because sulphate is directly associated with odour and corrosion problem.

Increase in sulphate concentration related to the pollution of the water body. Sulphate undergo transformation to sulphur and hydrogen sulphide under strong reducing conditions specially in the condition when the Dissolved oxygen is completely depleted and used for the organic matter break down by bacteria.

In the present study the concentration of sulphate was found in the range of 1.74 to 4.53ppm. in the year 2002 and between 1.65 to 4.67ppm. in 2003 at different sampling stations. The mean value of sulphate during study period of 2002 ranged between 2.75 to 2.77 ppm and in 2003 varied from 2.74 to 2.81ppm at various sampling stations. The highest value was observed in summer, season at June month at station-I, II and IV in 2002 and at station-I and II in 2003, due to deposition of westes and presence of rocks whereas minimum value observed in rainy season in the month of August at station-III, IV and V in 2002 and in 2003 at station-II due to high quantity of water body and dilution.

The present observation resemble with the work of Singh (1999) who recorded the sulphate value in the range of 0.021 to 10.960 in Narmada river. The sulphate showed positive correlation with C.O.D. and NH_4-N at most of the stations.

This factor includes MPN This factors includes MPN, Plankton (Phytoplankton and Zooplankton), aquatic weeds and economically important fishes which are discussed as under :-

Total Coliform (MPN)

Among the living organisms in aquatic ecosystem, Bacteria are the most abundant and sensitive to root cause of many ailments. Several types of Bacteria are found in water and each type has its own optimal requirements of growth and development. Hence bacterial community of water represents the environmental conditions. Contaminated water harbours several bacteria causing diseases such as typhoid, fever, dysentery, diarrhoea and cholera. These pathogenic bacteria present in water bodies contaminated by domestic sewage and other pollutants. All bacteria require phosphate which is utilized by growing organisms almost as fast as it is made available. Bacteria population is often considered as valuable indicators of pollution an eutrophication in aquatic ecosystem and high count in water is harmful for drinking and bathing purposes. This test directly show the deleterious effects of population on human health so it is the most useful microbiological parameter for assessing the quality of any water supply.

A desirable limit of coliform is zero number/100ml. in drinking water recommended by WHO. The actual number of coliform is difficult to report therefore they are reported as an approximate count, Most Probable Number (MPN).

Among the bacteria, coliform group is frequently used by assess the degree of pollution by excreta of warm blooded animals (Rao et. al.

1968 and Goldreich, 1970). Some more frequently used indicators of feacal pollution include feacal Streptococci and Clostridium perfringers .(Bonde, 1977).

Bacteriological investigation in river water have been carried out by Saxena et. al. (1966), Agrawal et. al. (1976), Kundra et. al. (1977), Singh & Bhomick (1985), Tiwari (1989) etc. Different workers have used different bacteria to assess the quality of water. Coliform bacteria was assessed as they are good indicator of faecal pollution.

Maximum bacterial population noticed where the city's main sewage outfall discharge, its wastes into the river. Saxena et. al.(1966) stated that increase of coliform organisms is due to discharge of sewage in to the river, high coliform count was noticed in summer and rainy season. A high bacterial population in the river water is indicative of the possible existence of associated pathogens and water may very well be a source of bacterial diseases specially intric diseases for rural folk inhabiting the areas lying along the river bank and using its water for their daily needs.

In the present study MPN of coliform organisms fluctuated from 55 to 1602/100ml. in the year 2002 and between 52 to 1606/100 ml. in 2003 at different sampling stations. The mean value of MPN during the study period of 2002 varied from 207 to 323.66/100ml. and in 2003 ranged from 200.5 to 324 .41 /100 ml. at different sampling stations. Maximum count of bacteria was noticed in summer and monsoon period at station-I, II and III due to temperature conditions, pollutants run-off and sewage from nearby area as a result of the washing of soil and organic matter etc. While minimum count was observed in January at station-I, IV and V due to low temperature and lacs of run-off.

The present findings are in conformity with the observation of Doctor et. al. (1998) recorded MPN between 300/100mm. to 1600/100mm. in the river Bhadar.

Besides fair occasions the regular mass bathing activities increase the bacterial pollution all over the stretch of river Ken in Banda district. The coliform load in river water indicates that bacteria are always, under all conditions remain in water body. Statistically total coliform showed significant positive correlation with temperature, turbidity and phosphate at most of the selected stations from I to V during the study period.

Plankton

Phytoplankton (Microflora)

Studies of Phytoplankton of water bodies is very helpful to know its general economy and to understand the basic nature of the water. The importance of phytoplankton is that they release oxygen in water by photosynthesis process which taken by fishes. Some phytoplankton make the water eutrophic which is hindrance the fish movement and water become polluted.

In the present study phytoplankton were observed qualitatively and quantitatively which are belongs to the group of Chlorophyceae, Bacillariophyceae and Mixophyceae (Cyanophyceae). Phytoplankton of the river is generally composed of a wide variety of forms that are the greatly affacted by the surrounding environment. Discharge of sewage wastes drastically change the

quality of water and consiquently the composition of phytoplankton (Palmar, 1957; Laxminarayan, 1965; Venkateswarlu, 1969; Patrick, 1953; Verma et. al., 1984).

Profuse growth of phytoplankton due to addition domestic sewage and waste water effluents has been reported by Piecznaske et. al. (1975) and Lee (1977). Munawar (1974) has recorded an increased phytoplankton population in sewage contaminated rivers and ponds. It was observed that the density of phytoplankton population at peak development during summer and minimum in rains. Jha (1982) and Tiwari (1983) have reported primary maxima during summer, secondary during winters and lowest during mansoon.

The present findings are agreement with these observations. During the course of study period chlorophyceae group was dominated over rest of the phytoplankton population.

Group-A :Chlorophyceae

The chlorophyceae group varied from 16 org./l to 161 org./l during the period of study (2002-2003). It was abundant during post monsoon period and summer, in the rainy season its density was lesser. these variations were noticed as a summer season due to much concentration of nutrients and low amount of water and high photosynthesis due to long duration of sunlight and high rate of temperature whereas in rainy season high water currents, much water amount which cause dilution of nutrients and turbidity which retards the photosynthetic activity due to hindrance of radiation their impact is directly on the growth of the chlorophyceae.

Kant & Kachroo (1977) and Kant & Anand (1978) discribed a gradual rise in temperature from February onwards as optimal condition for growth and reproduction of chlorophyceae. During the present study there was a gradual rise

in the population of chlorophyceae from February onwards and touched a peak level in April to June. These findings are in conformity with the present work.

Group-B : Bacillariophyceae

In Ken river diatoms recorded between 12 org./l. to 120 org./l. in year of 2002 and in the year 2003 it ranged between 12 org./l. to 117 org./l.. The highest value was observed in the month of May in both year of study, due to decomposition of organic wastes, which serve as a good source of nutrient and stimulate the growth of diatoms. It has been cited by many other investigators also (Brinly, 1942; Wagar and Schumacher, 1970), whereas lowest value of recorded in the month of August due to strong current velocity and low water temperature. Eddy (1934) stated that stability of water is good ecological condition for plankton production. Sluggish current of summer associated with maximum diatoms population also supports the above view. Hence the works are in resemblance the present works.

In river Doothganga, strong current velocity resulted in low plankton population (Rishi, 1983). In river Bhagirathi too, the maximum phytoplankton population was observed when turbidity and current velocity were low (Sharma, 1985). High turbidity produces an injurious blanketting effect on the phytoplankton and kills them (Welch, 1952; Roy, 1955 and Chakrabarty et. al. 1959). Jha (1982) and Tiwari (1983) have also recorded thin phytoplankton population during rains. Naviculla, Synedra, Diatoma, Cymbella, Pinnularia recorded both polluted and unpolluted stations. In the present study the summer months (May and June) peak of diatoms were noticed. A direct relationship of temperature with diatoms population was recorded by Sharma and Pant (1979). The present work is also in conformity with the above works. So it is inferred that bacillariophyceae was second dominant during the summer season.

Group-C : Cyanophyceae

Blue green algae flourish in all aquatic ecosystem because they have an extra ordinary functional structural hetrogenicity (Carr and Whitton, 1973). These are useful for phytosynthetic ability, chemotrophic and hetrotrophic capabilities. Blue green algae were the second dominant group among phytoplanktonic community these marked at all stations mostly in summer when pollution was high. High temperature and cyanophyceae are directly correlated (Chakrabarti, Laxminaryanan, Rishi and Tiwari). Rai and Kumar (1977) observed that high nutrient concentration was required for peak development of cynophyceae.

In the present study it varied 25 to 132 org./l. in the year of 2002 and in 2003 ranged between 25 to 129 org./l.. Microcystis was most dominent member of blue green algae. In spite of the presence of Microcystis, Ocillatoria appeared as the second dominant genus of cynophyceae during the period of study. Ocillatoria is more responsible for eutrophic conditions. Nostoc was the third dominant genus in the total stretch of the river. Ganapati (1940) found low dissolved oxygen of water associated with abundance of Microcystis, Ocillatoria species and others during summer when dissolved oxygen was quite low confirms. During the study high level of ammonical nitrogen and organic matter were found more which are responsible for growth of blue green algae. The present study resembles with the work of above workers. Blue green algae is able to use bicarbonate more efficiently than other species of algae thereby enabling them to photosynthesize at lower carbon-di-oxide concentration and resulting in more carbonate during their abundance (King, 1970; Shaprio, 1984). Due to this fact a positive correlation was found between carbonate alkalinity and blue green algae. A strong positive correlation was also found between blue green algae and phosphate. It is capable of utilizing first of all ammonical nitrogen directly.

From the above discussion it is evident that blue green algae found only at some stations having high temperature, organic matter coupled with low D.O. condition under which blue green thrive well as compared to other classes of algae.

The characteristic feature of blue green algae is for more growth and protection of crops therefore it is very good organic fertilizers specially for the paddy fields.

Zooplankton (Microfauna)

The assemblage of microscopic free floating animals from the integral part of an aquatic ecosystem which are zooplankton.

Zooplankton occupy the central position between the autotrophs and heterotrophs and form an important link in aquatic food web, these are used as food by some fishes which are plankton feeders. In fresh waters there are dominated by Rotifers, Cladocerans and Protozoans (Verma and Shukla, 1969; Desai et. al., 1983; Sarkar et. al., 1986; Sharma, 1967).

It has been reported that zooplankton favour less light and moderate temperature and are directly related with dissolved oxygen (Singh and Singh, 1985). Lall et. al. (1986) pointed out that poor density of zooplankton and abiotic factors indicate oligotrophic condition.

In the present study Protozoa were noticed qualitatively 7 genera mainly they ranged between 2 org./l. to 86 org./l. these are found very rare in number at most of the stations, Rotifera were observed 5

genera, mostly they have seen in summers. They increased gradually from spring to summer but in winter it was sporadic (Pokkie, 1968). Rotifers co-related with higher alkalinity and temperature condition (Michael, 1964). The density of Rotifers found higher than total zooplankton. They were observed in the range of 9 org./l. to 94 org./l. in the investigation period, their maximum number were seen in the month of June due to high turbidity and organic discharge by sewage at station-I and II.

Copepode and Cladocerans indicate the incidence of organic pollution (Anthony et. al., 1979). They were observed 5 genera each. Cladoceran ranged 4 org./l. to 99 org./l. in both year of the study, whereas Copepode investigated 7 org./l. to 71 org./l. in 2002 and in 2003 it found 7 org./l. to 73 org./l..

Copepode and Cladocerans dominated during monsoon whereas Rotifers dominant during summer. Copepode and Cladocerans found maximum in rainy season due to high turbidity and high alkalinity.

The summer peak of zooplankton might be due to high temperature, which stimulate the reproduction and development of zooplankton. Higher pH, alkalinity and some other important nutrients during summer have directly or indirectly favoured the development of zooplankton population. Phytoplankton serve as food of zooplankton and their abundance during summer season may have enhanced the population of the zooplankton in the river.

The present work is in conformity with the other studies done by Vasisht and Dhir (1970), Sharma (1983) and Shukla et. al. (1995)

Aquatic weeds (Macroflora)

A number of unwanted aquatic weeds viz-Hyacinth, Pistia, Wolfia, Nymphoids, Nelumbo, Nymphea etc. grow prolifically in water due to ammonical nitrogen and phosphorus, they reach in water through the sewage and run-off which cause water pollution and water-borne diseases.

Excessive growth of aquatic vegetation prevents effective utilization of water and reduces productivity. They check free movement of the fishes and cause oxygen depletion and accumulation of carbon-di-oxide. Gases like hydrogen sulphides and methane are formed which are harmful to the fishes. Algal blooms choke the gills and spoil the water on rotting.

The prolifically growth of aquatic weeds chocked many river, irrigational canals, ponds and lakes in India, resulting enormous direct and indirect losses. The accompanying economical losses caused to the farmers, traders, fisheries and public utilities are often considerable (Sculthrope, 1967). These are the harmful than beneficial for fish culture. It's menace by blocking water ways and interfering with hydroelectric production, wasting water in evapotranspiration, hindering traffic and fishing which causes water-borne diseases (Katyal and Stoke, 1989).

The human activity spot on the rivers become heavily infested with a variety of aquatic weeds which cause interference with a variety

of aquatic weeds with the religious ablution of the pilgrims (Dutta and Gupta, 1976).

In the present study period (2002-2003), it was noticed that the free floating species, Lemna paucicostata, Trapa bispinosa, Eichhornia crassipes, Azolla species etc. are found and their growth started from October and made scum in shore region and they began to deplete from April onwards whereas submerged species Potamogeton spp. found very small in number which is disappeared in monsoon period. Ceratophyllum, Hydrilla and Vallisneria are the most abundant in station-IV and V. This density becomes less in monsoon period while Vallisneria occurs in shallow region.

Free floating forms predominate at some places and easily spread to other parts, Lemna spp., Spirodella spp. and Azolla spp. colonise at such places where river forms side pools at station-II and IV appearing almost stagnant. Dense growth of Eichhornia spp. cover tributries, nala and lowland impoundment arround the river. These areas of weed propagation functions as permanent sources of drifting vegetation which enters the river at the time of flooding. The colonies of connected rosettes of Trapa spp. are usually seen cultivated along the river by the local inhabitants.

Submerged and floating level form maximum coverage and pure as well as mixed associations in deeper parts of the river where they block it and reduce the flow of water. Hydrilla spp., Ceratophyllum spp., Nechamandra spp., Vallisneria spp. and Potamogeton spp. all forming mixed associations. Marselia, Chara and Nitella spp. form subaquatic meadows in the marshy and shallow isolated channels at

stations-II and IV. Otellia spp. is rarely seen totaly submerged but is found only at shallowest part at station-III.

Abundance of macrovegetation appear with the arrival of rainy season a large amount of minerals and organic matter are discharged in to the river from the nearby areas including domestic sewage and added to the fertility of the bottom soil. They gradually and steadily settle along the river basin. Silting of the river varies according to nature of the river bed. Considerable amount of silting is observed at station-II, III, IV and V. Discharge of raw domestic sewage and other wastes are also responsible for the enrichment of the bottom, mineral soil. Such soil prompting the luxuriant growth of the weeds. Weeds decay material added to the fertility of the bed.

These infested areas through inlets are outlets during flood, regular vegetative propagation and dispersal of sexual propagules are the main source of infestation.

The aquatic weeds which are menace to the reverine system as the river Ken is also affected by this, so its management can be made by taking measures such as leaching of ammonical nitrogen, phosphate and good manure can be obtained by composting the weeds in pits which is utilized for agricultural lands as fertilizers.

Fish fauna (Macro fauna)

Fishes are the useful parameter (Factor) to assess the real state of purity in water. They are a major component of most aquatic habitats and water pollution affects all aquatic organisms including in fish. Natural or man made pollution in the water changes pH, temperature,

turbidity, flow regime, Dissolved Oxygen and affect the fish population and fisheries component. They are the primary indicaters of pollution of rivers because fish or conspicuous.

Fishes are constitute economically a very important group of animals. The importance of fish culture as a source of food production was then driven home more realistically and emphasis was laid on the need for extending fish culture activities to all the parts of the country with a view to developing the industry on scientific lines, both the in the private and public sectors (Jhingran, 1991). Besides being used as food, fish lives in an important source of oil containing vitamins A and D, their body oil used in soap industry and tanning. Fishes also yield fish meal, fish manure, isinglass and several other products of commerce.

Zoological survey of India (1991) has published that about 400 spp. of fishes which are found in Indian water. Gunther (1880) found 26 families in India, Day (1885) reported 87 genera in Indian fresh water.

The present investigation revealed that various fishes of economic values and hill stream fishes are found in the river Ken inwhich 38 spp., 28 genera, representing 14 families were studied in river Ken. Labeo rohita, Cirrihinus mrigala, Mystus seenghala, Xenantodon cancila, Clarius batrachus and Heteropneustes fossilis were more abundant in river Ken during the period of study (2002-2003).

The Ken river has generally a bed of coarse brown sand but some places the banks of muddy and have vegetation. The station-I which is in upstream near Rajghat is shallow and very less number of fishes are found and at station-V which is the confluence of Ken and Yamuna, have more fish than all the selected station due to deepness of river, vast water bodies for the fish movement.

The fish fauna of Ken river is characteristics in having both plain and hill stream fishes i.e. Garra gotyla, Lepidocephalichthyes guntea etc.. The presence of these fishes has own speical feature because of hilly origin and it is advantageous for research work which might be carried out on these hill stream fishes at plains.

Atmospheric Temperature (^{0}c)

2002

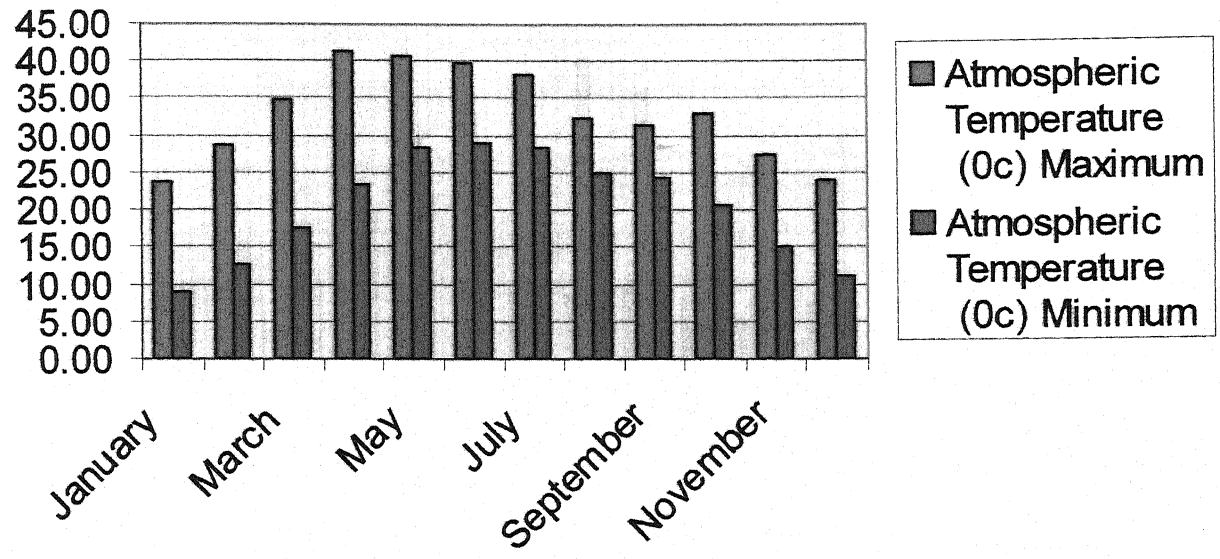


Fig 2

2003

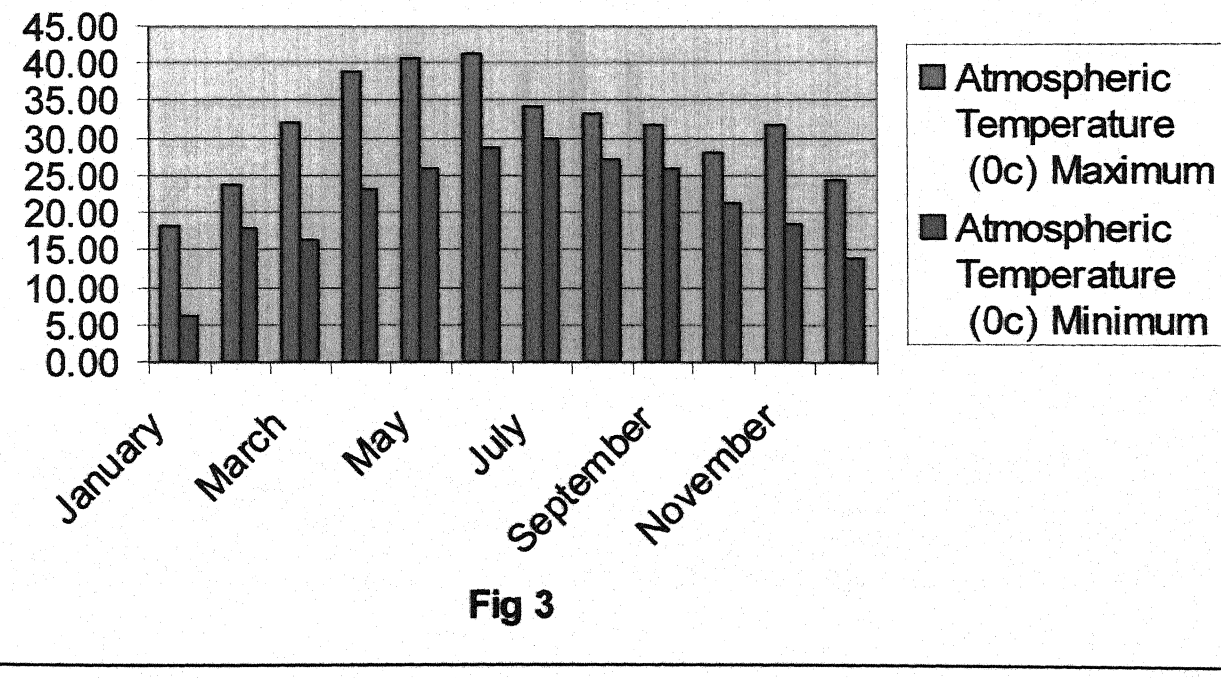


Fig 3

Water Temperature (^{0}C), Turbidity (N.T.U.), & Chloride (ppm.)

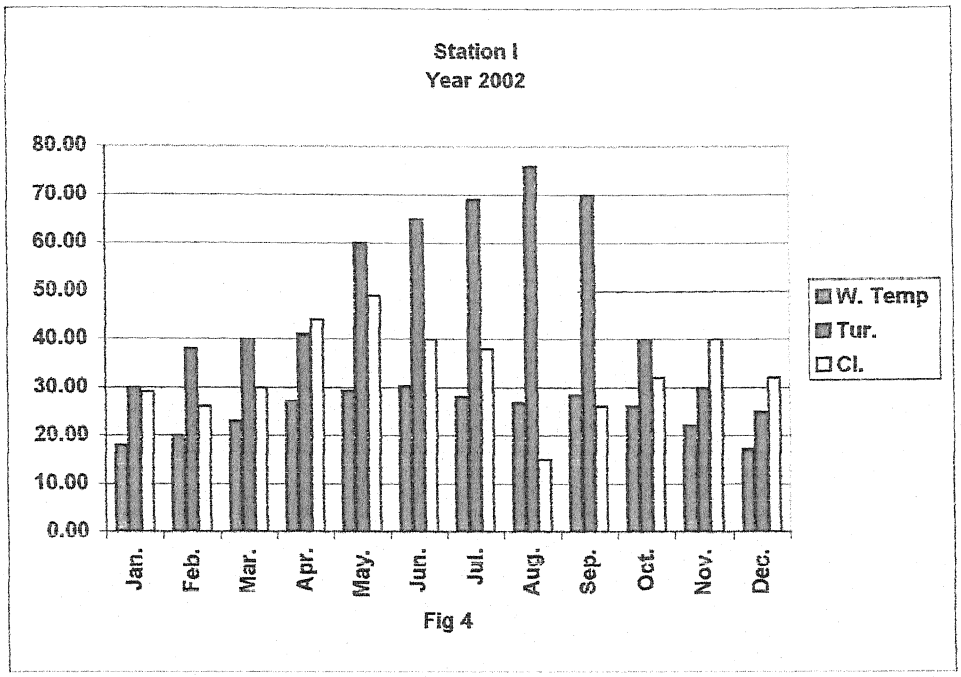


Fig 4

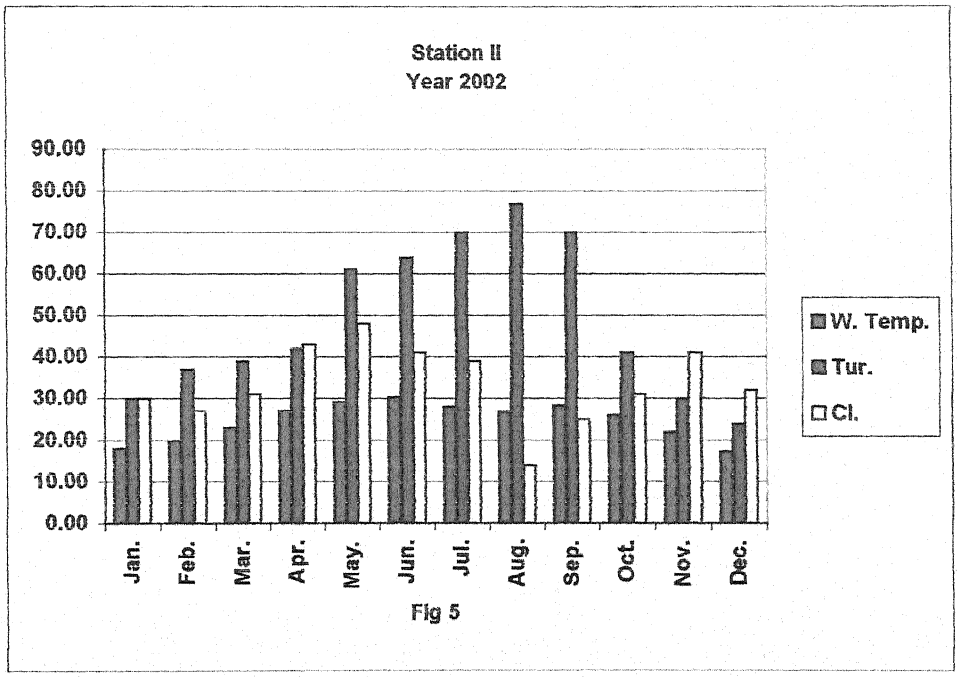


Fig 5

Water Temperature (0C), Turbidity (N.T.U.), & Chloride (ppm.)

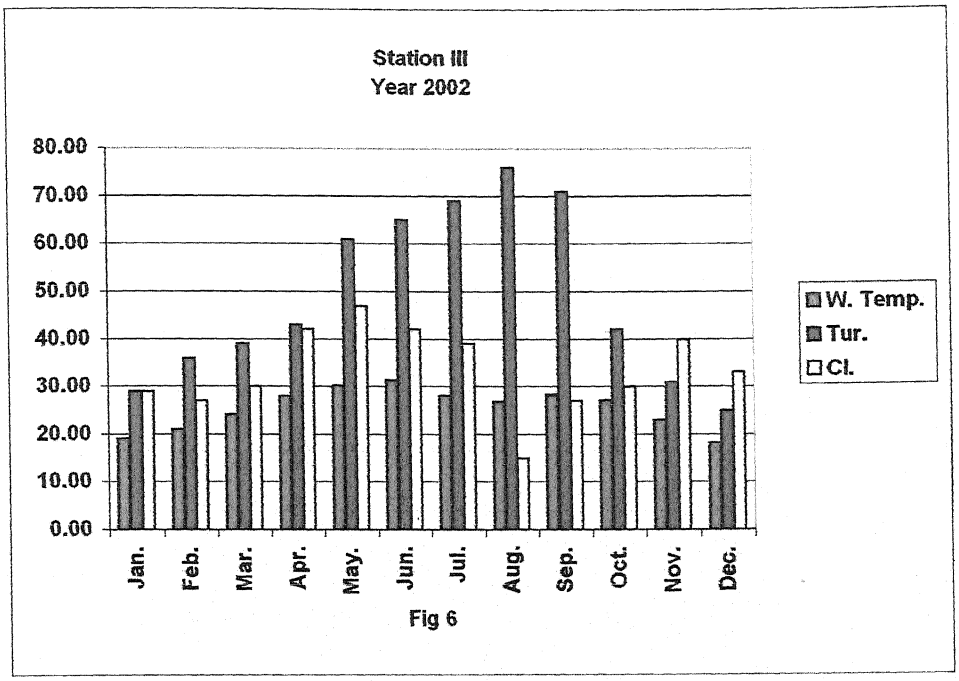


Fig 6

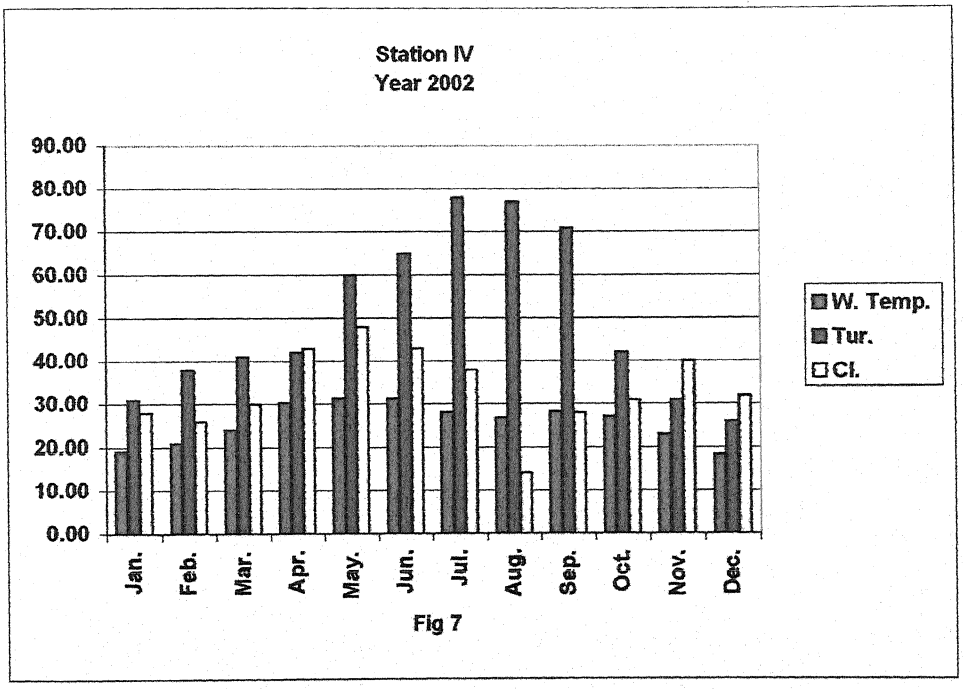


Fig 7

Water Temperature (0C), Turbidity (N.T.U.), & Chloride (ppm.)

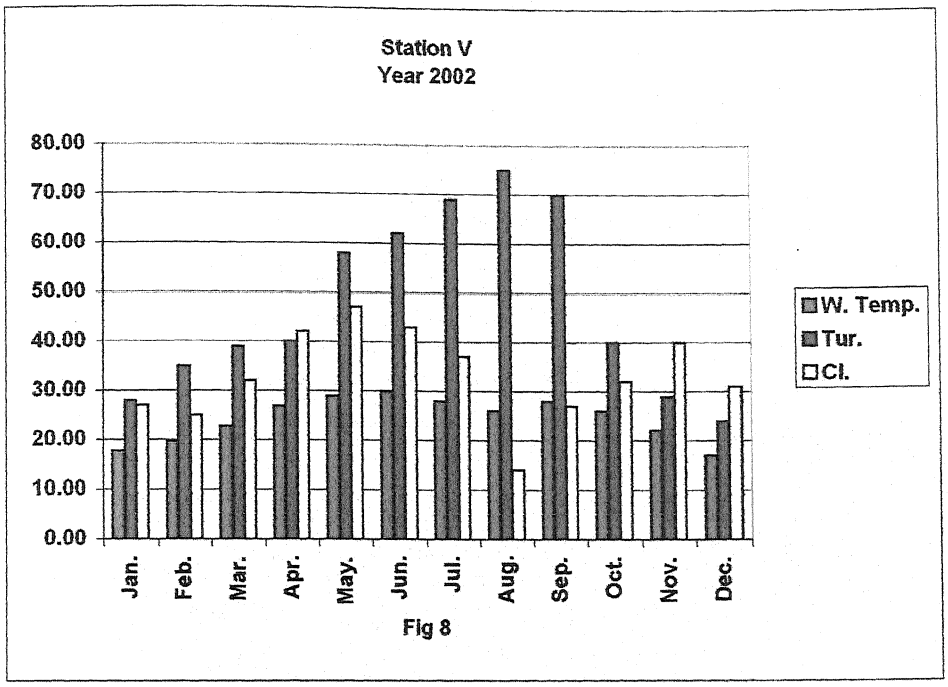


Fig 8

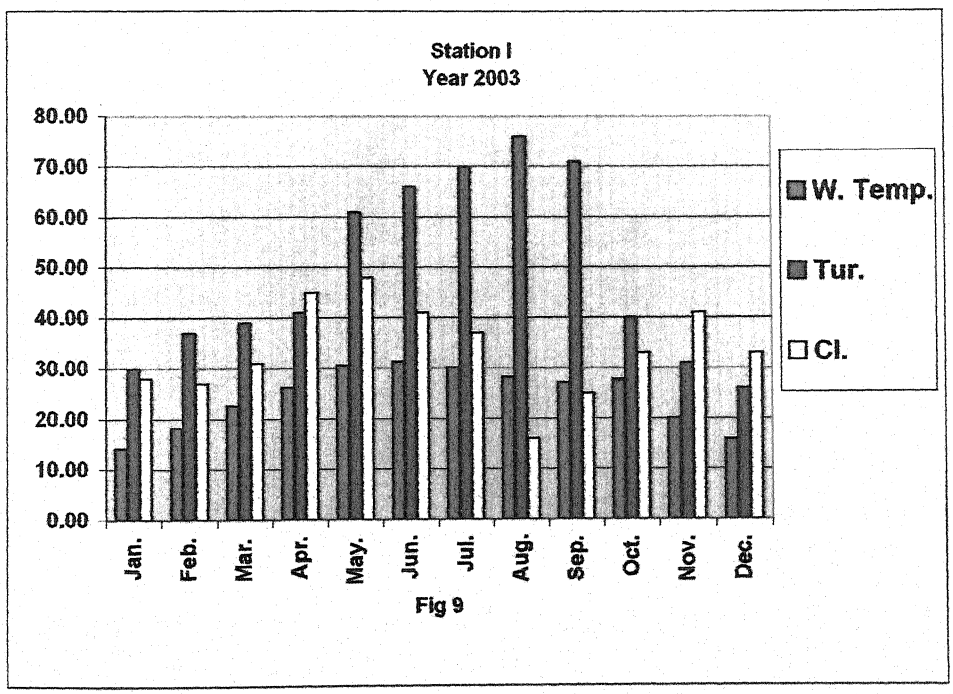


Fig 9

Water Temperature (0C), Turbidity (N.T.U.), & Chloride (ppm.)

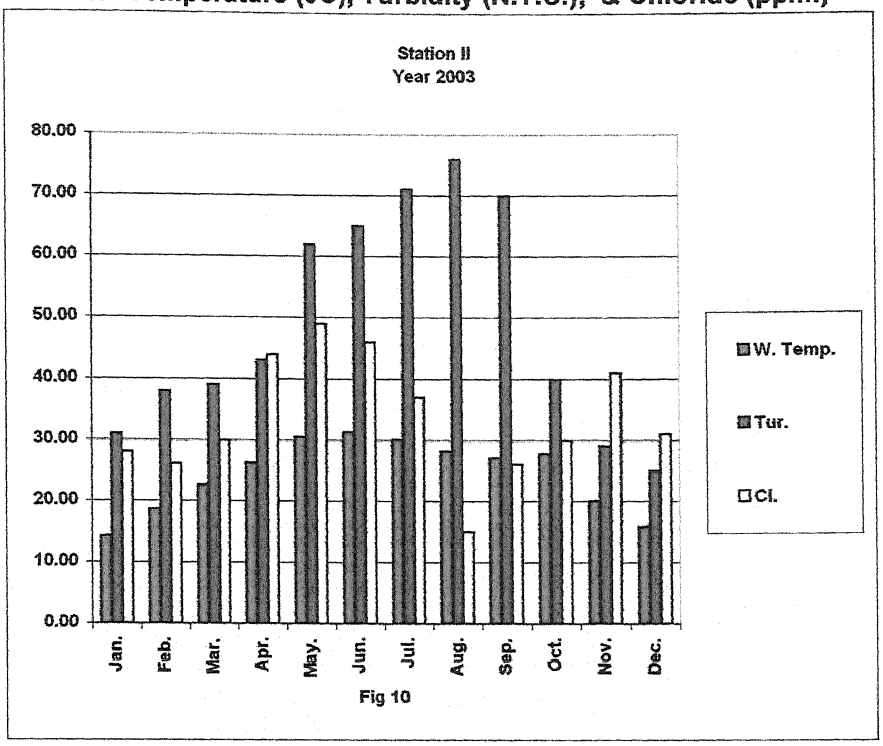


Fig 10

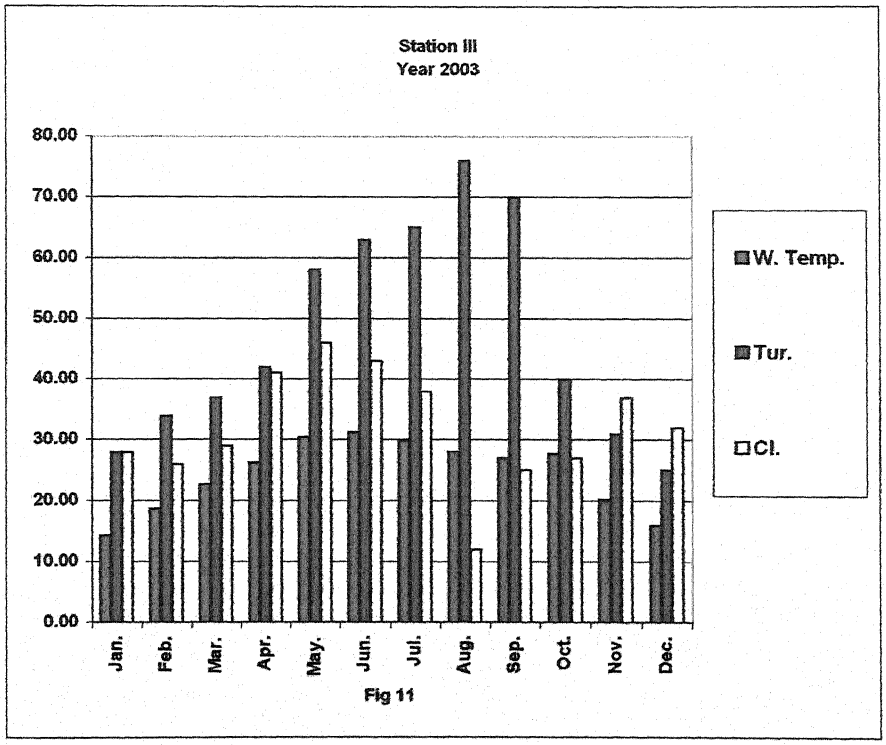


Fig 11

Water Temperature (0C), Turbidity (N.T.U.), & Chloride (ppm.)

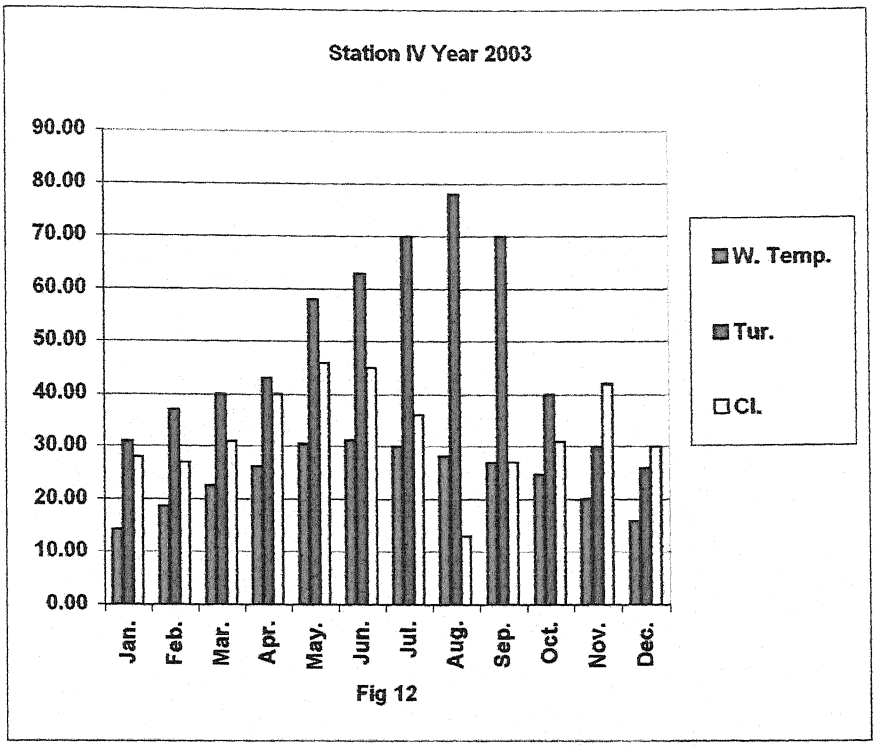


Fig 12

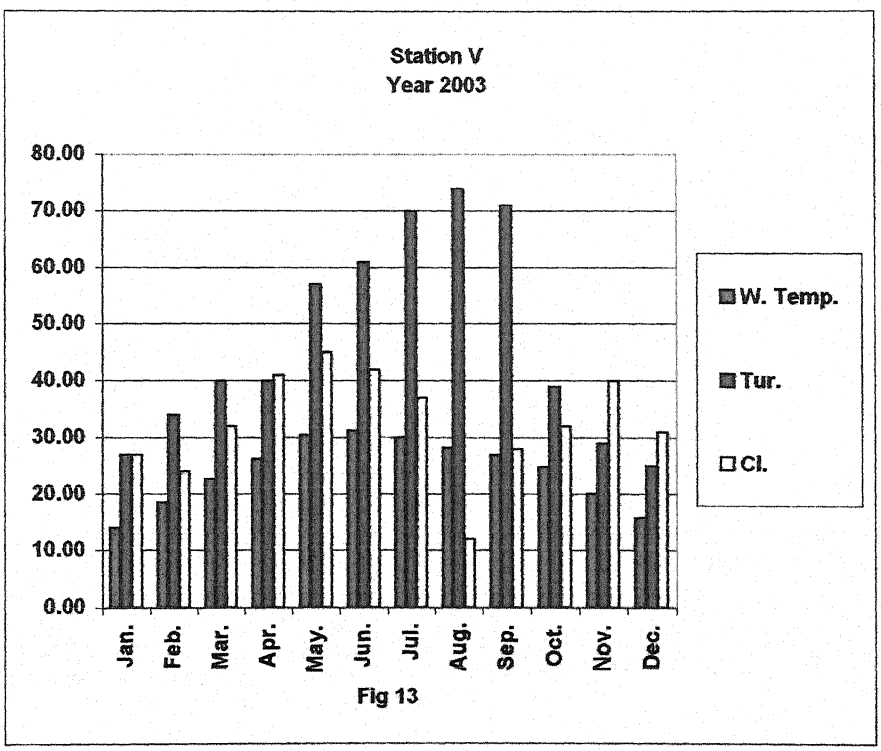


Fig 13

Hydrogen- ion - concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

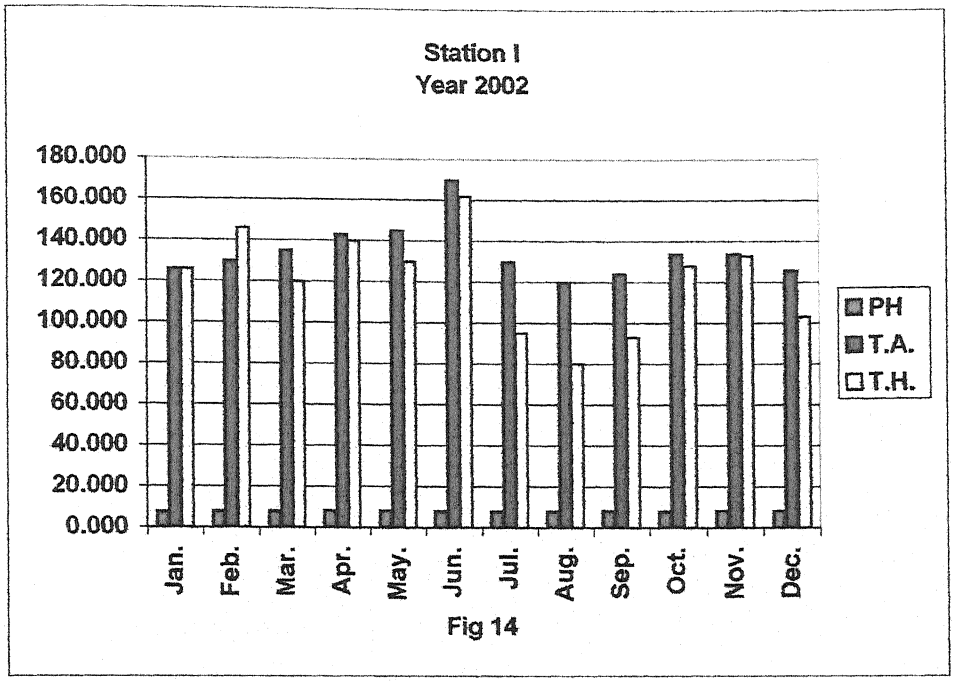


Fig 14

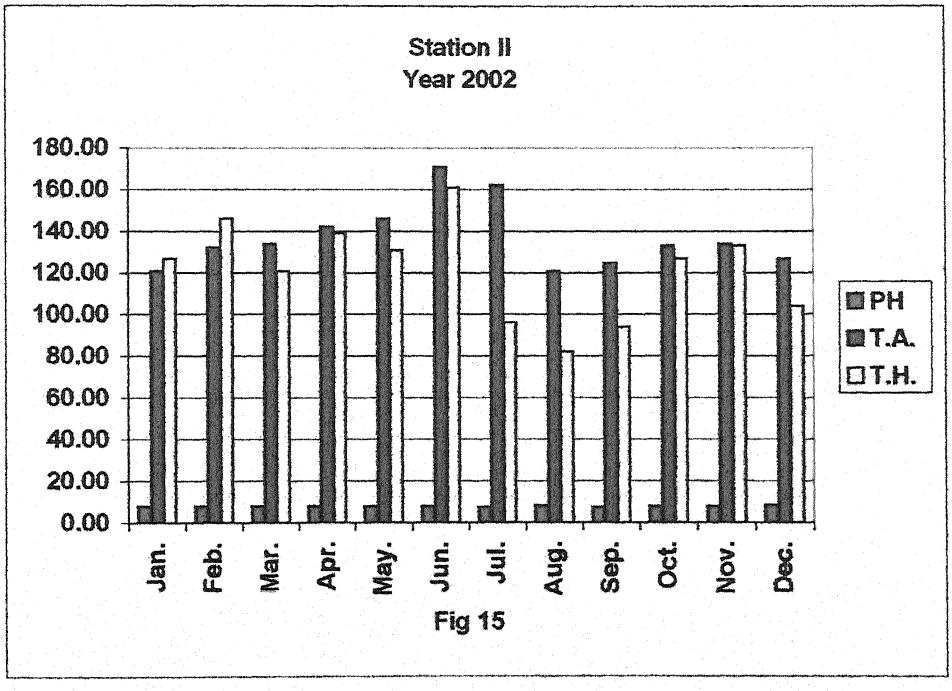


Fig 15

Hydrogen- ion - concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

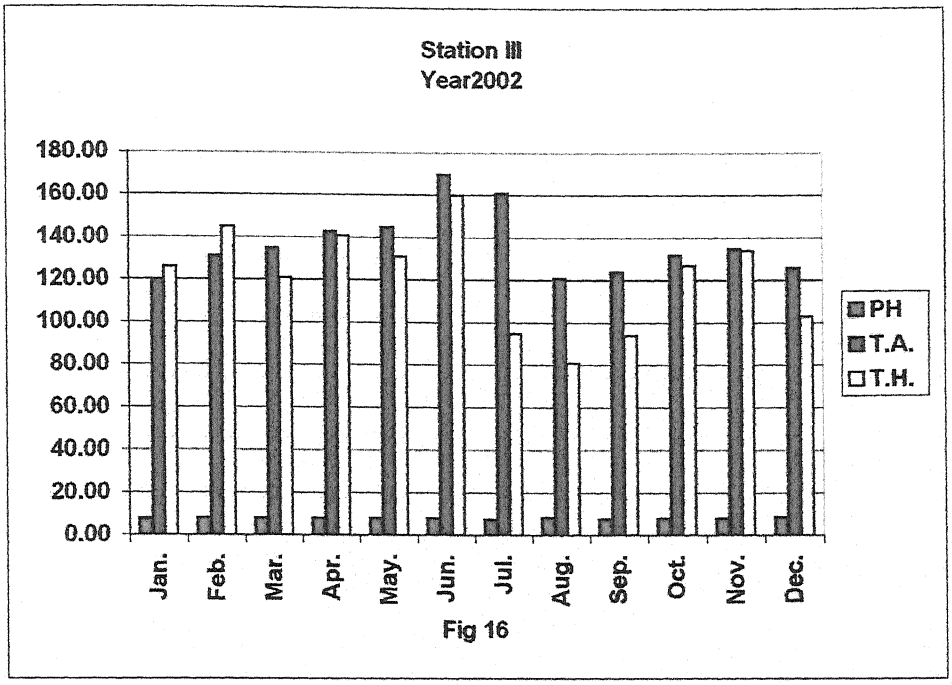
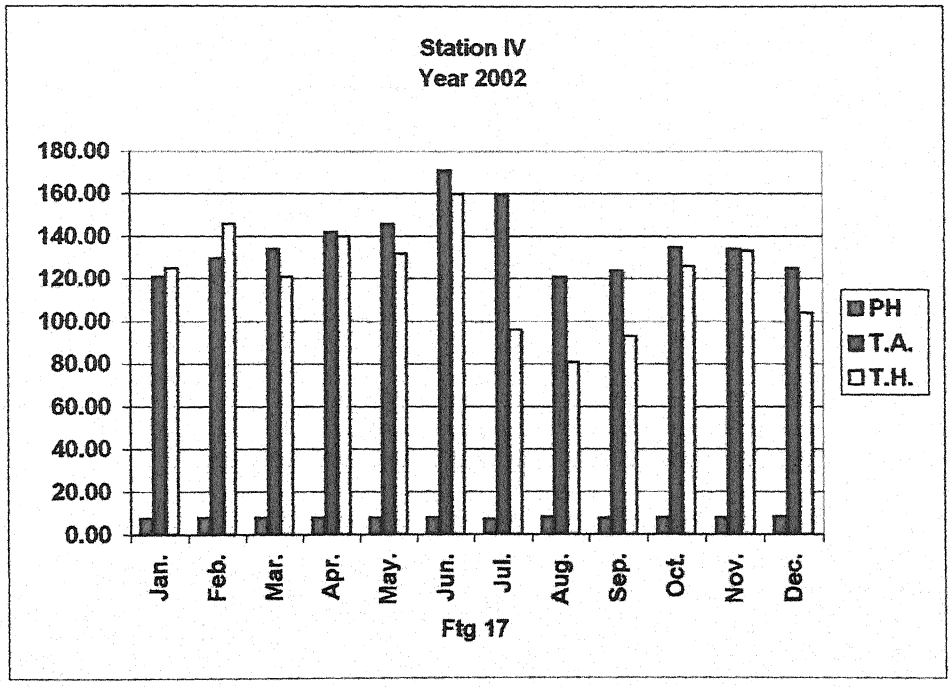


Fig 16



Ftg 17

Hydrogen- ion - concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

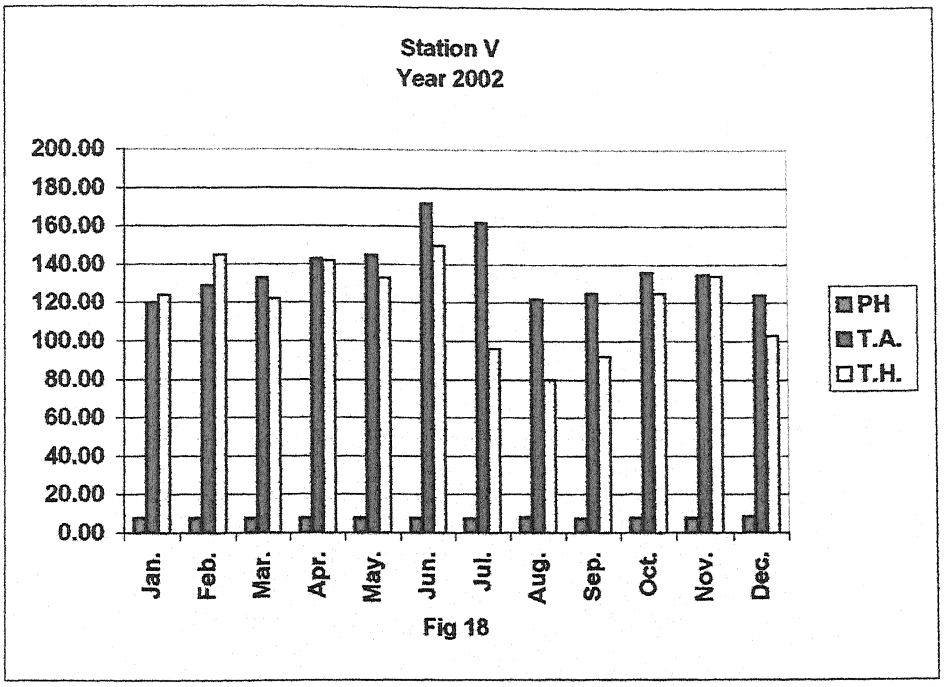


Fig 18

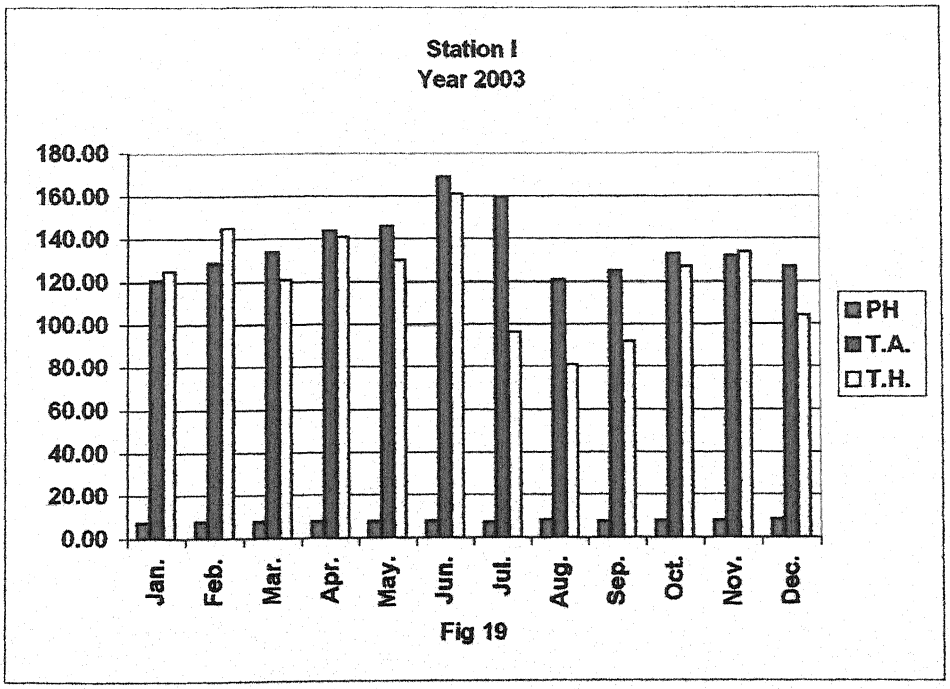
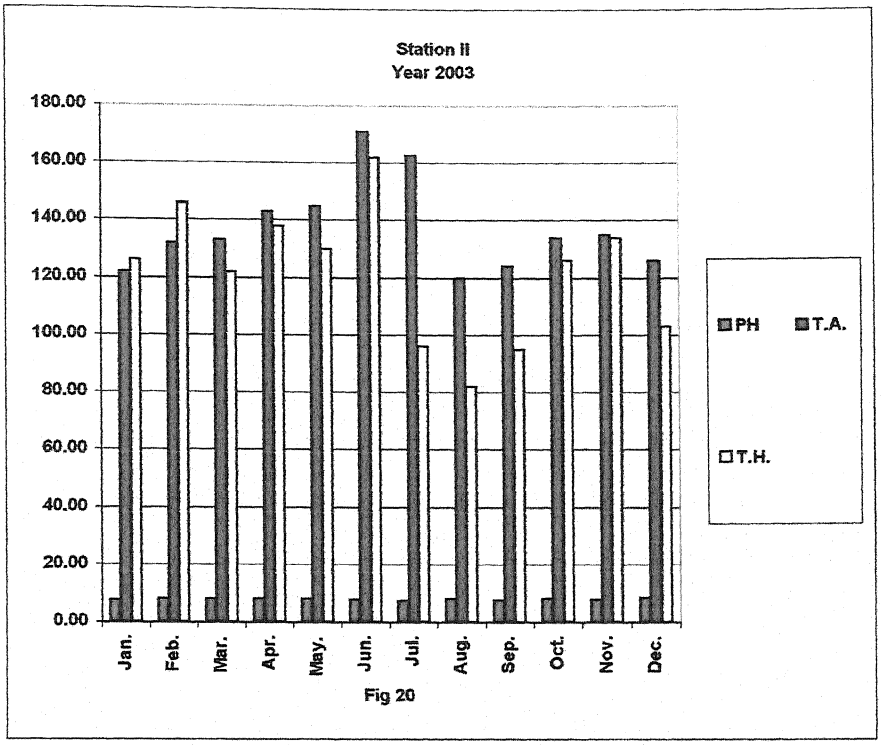


Fig 19


Station II
Year 2003
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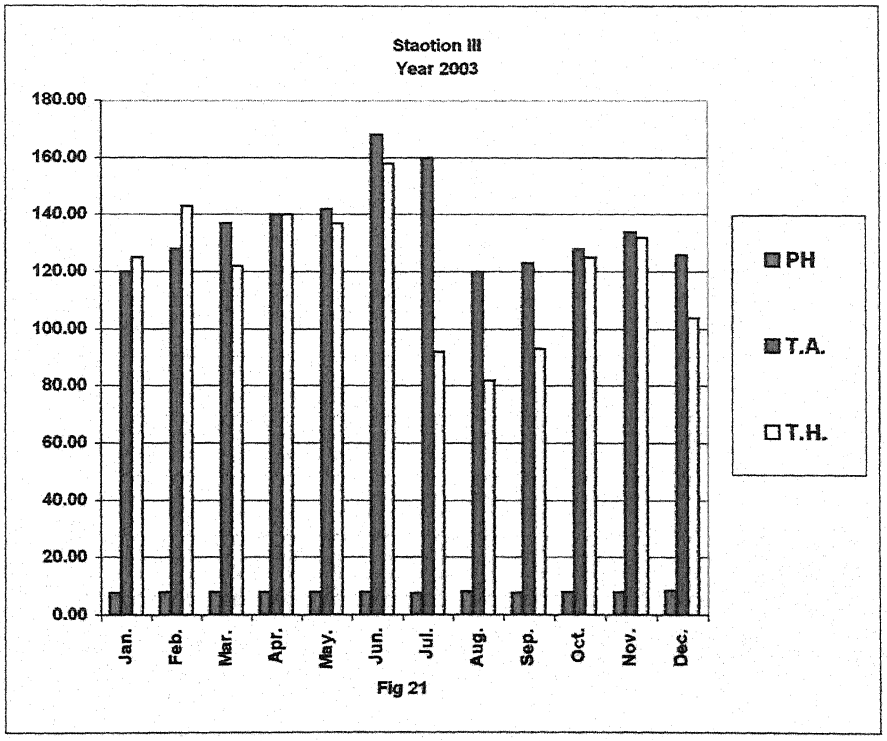
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
PH
T.A.
T.H.
Fig 20


Staotion III
Year 2003
180.00
160.00
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80.00
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Jan.
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Mar.
Apr.
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Aug.
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Dec.
PH
T.A.
T.H.
Fig 21

Hydrogen- ion - concentration (pH) Total Alkalinity (T.A.) Total Hardness (T.H.)

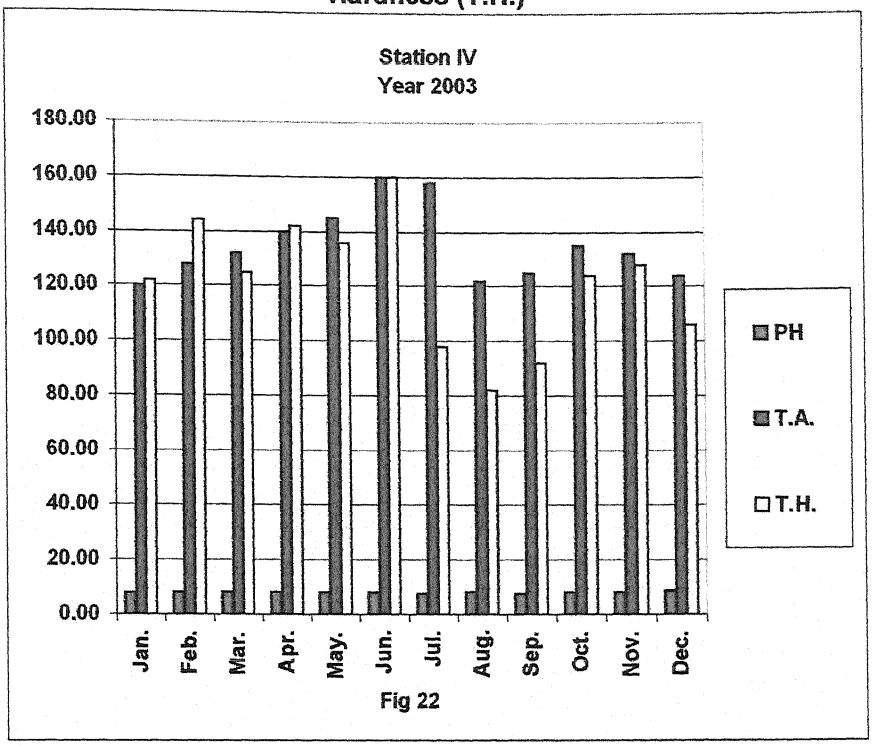


Fig 22

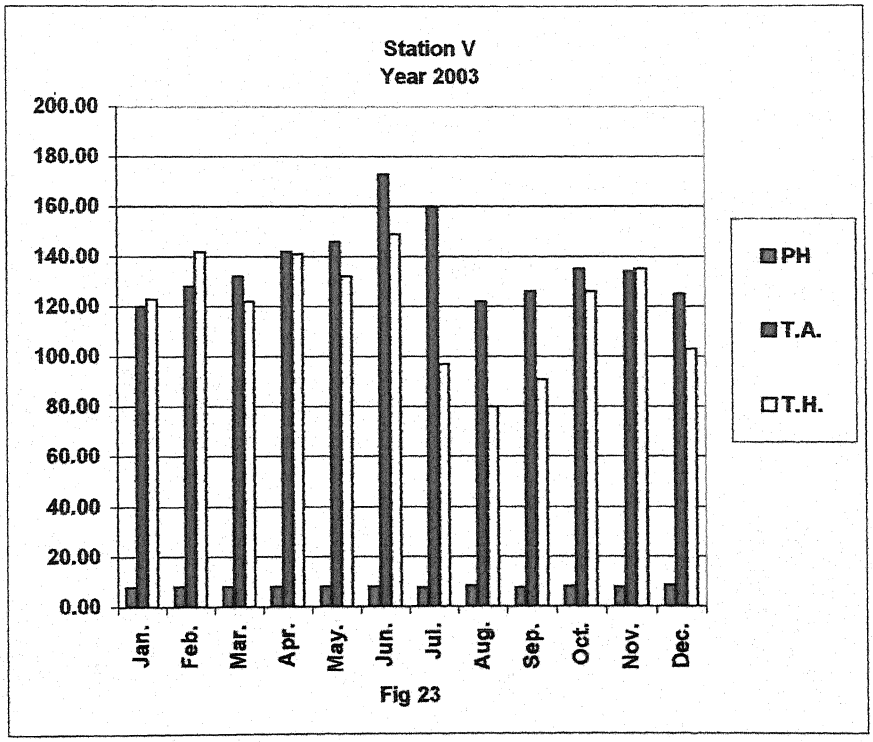


Fig 23

Dissolved Oxygen (G.O.) Biochemical Oxygen Demand (B.O.D.)
Chemical Oxygen Demand (C.O.D.)

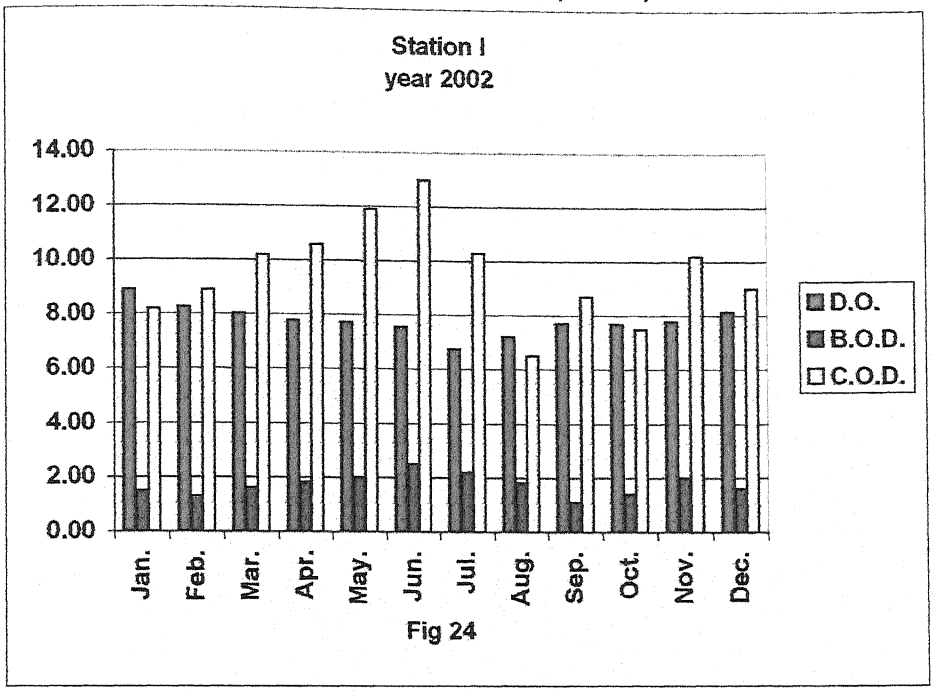


Fig 24

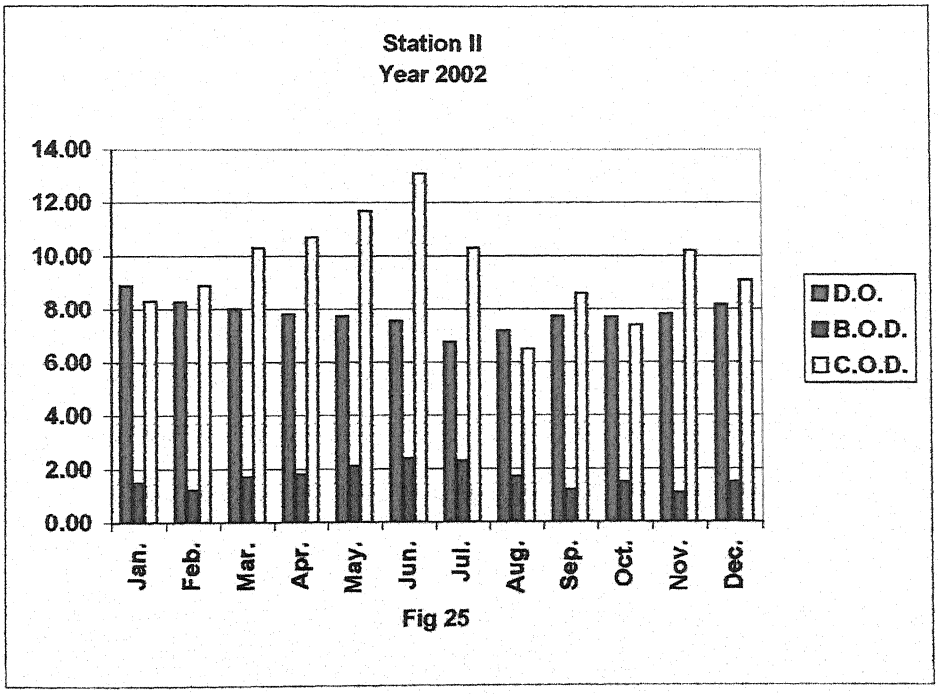


Fig 25

Dissolved Oxygen (G.O.) Biochemical Oxygen Demand (B.O.D.)
Chemical Oxygen Demand (C.O.D.)

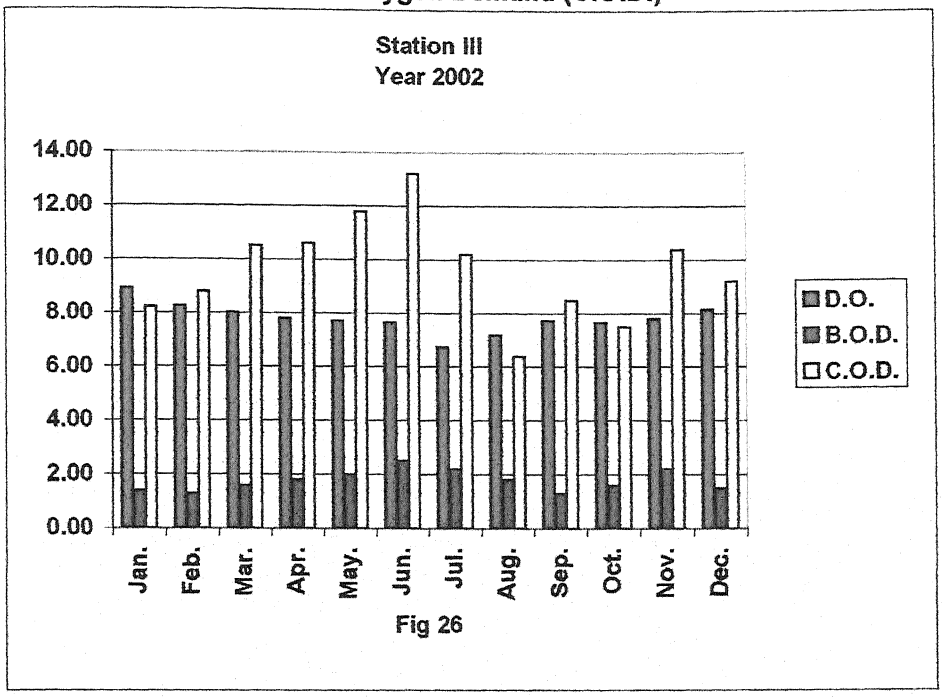


Fig 26

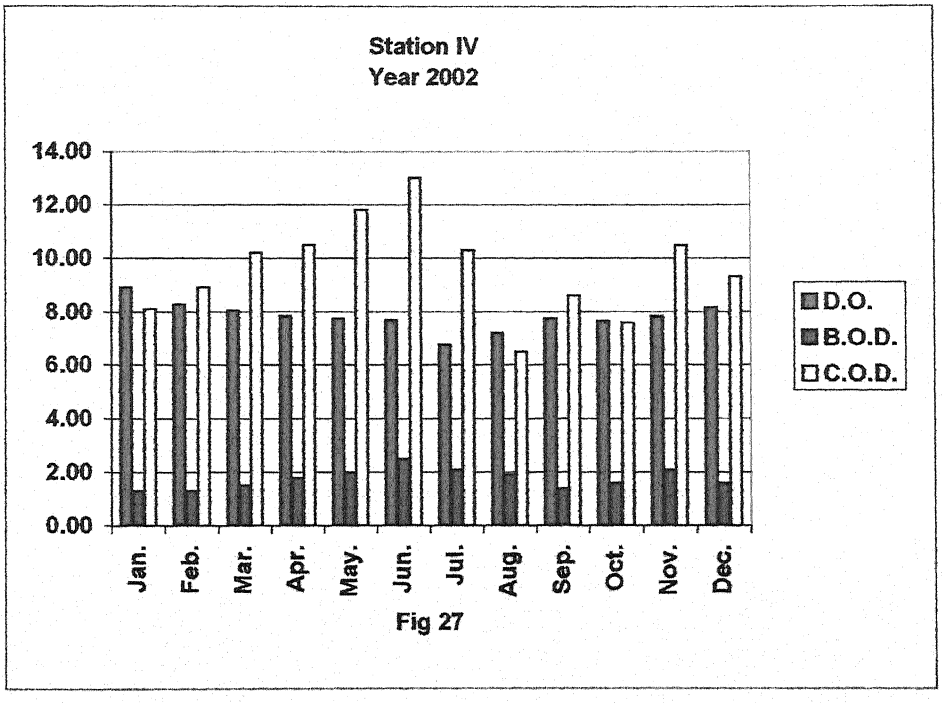


Fig 27

Dissolved Oxygen (G.O.) Biochemical Oxygen Demand (B.O.D.) Chemical Oxygen Demand (C.O.D.)

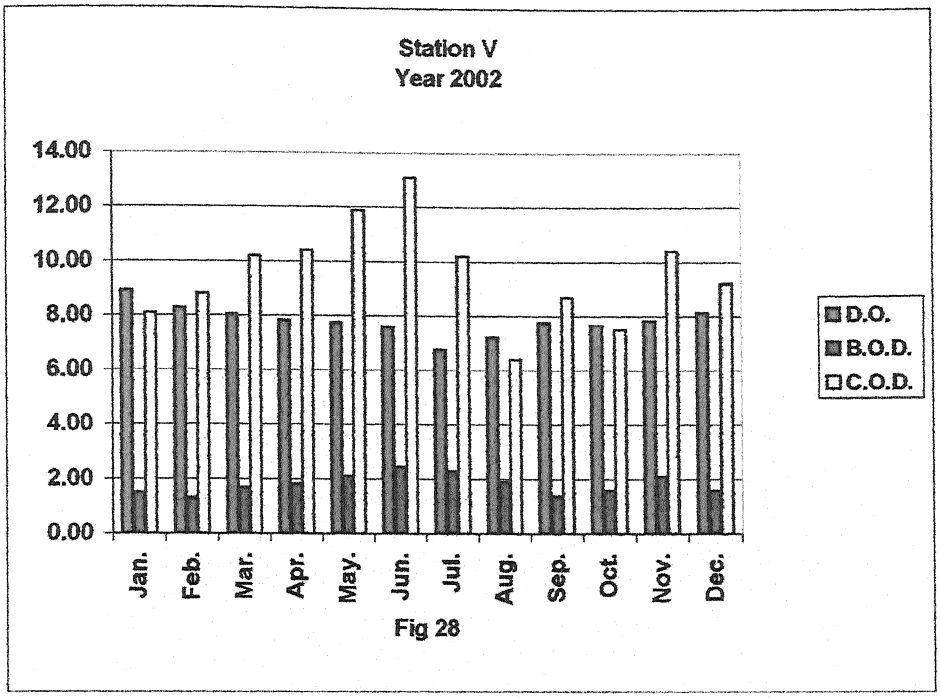


Fig 28

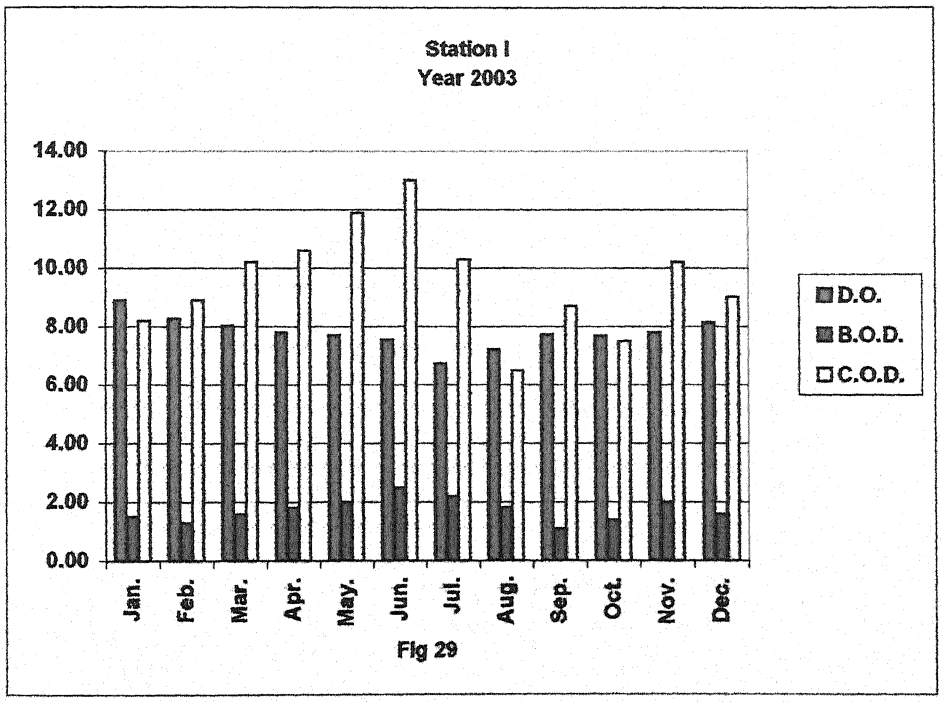


Fig 29

Dissolved Oxygen (G.O.) Biochemical Oxygen Demand (B.O.D.) Chemical Oxygen Demand (C.O.D.)

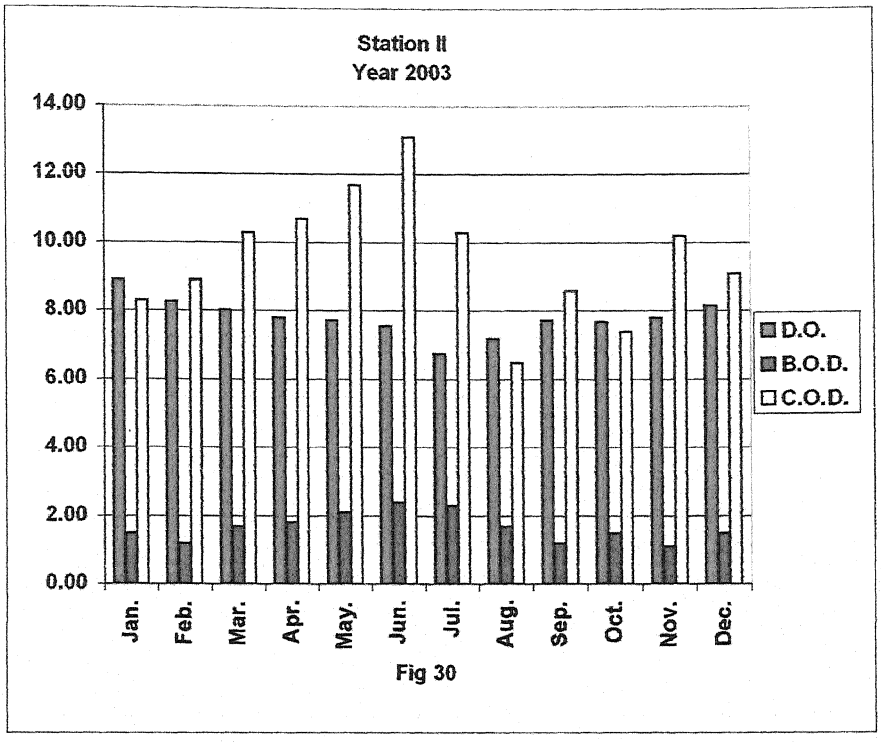


Fig 30

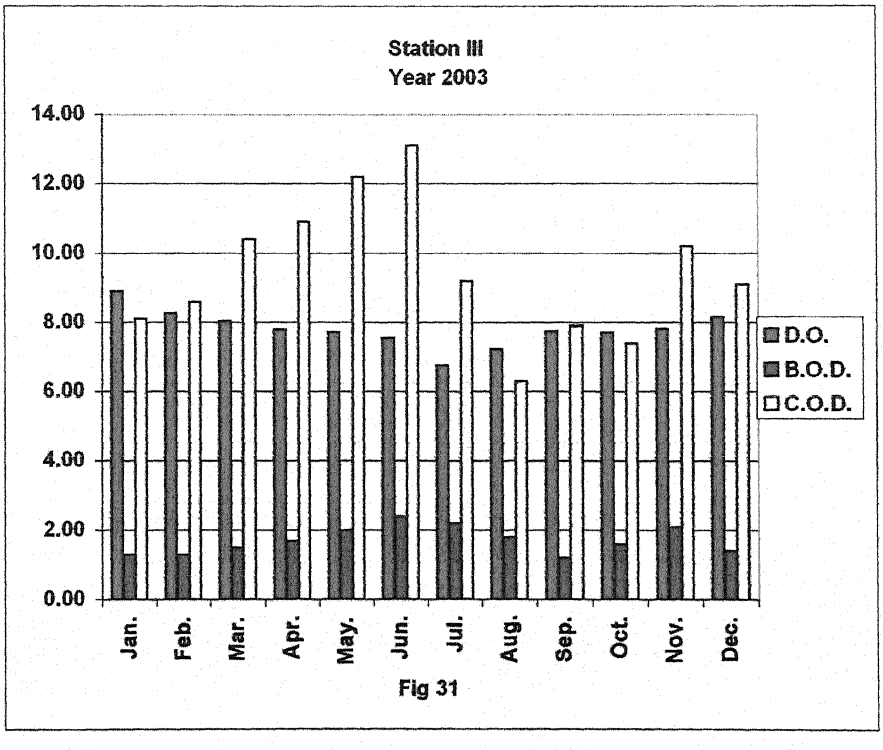


Fig 31

Dissolved Oxygen (G.O.) Biochemical Oxygen Demand (B.O.D.) Chemical Oxygen Demand (C.O.D.)

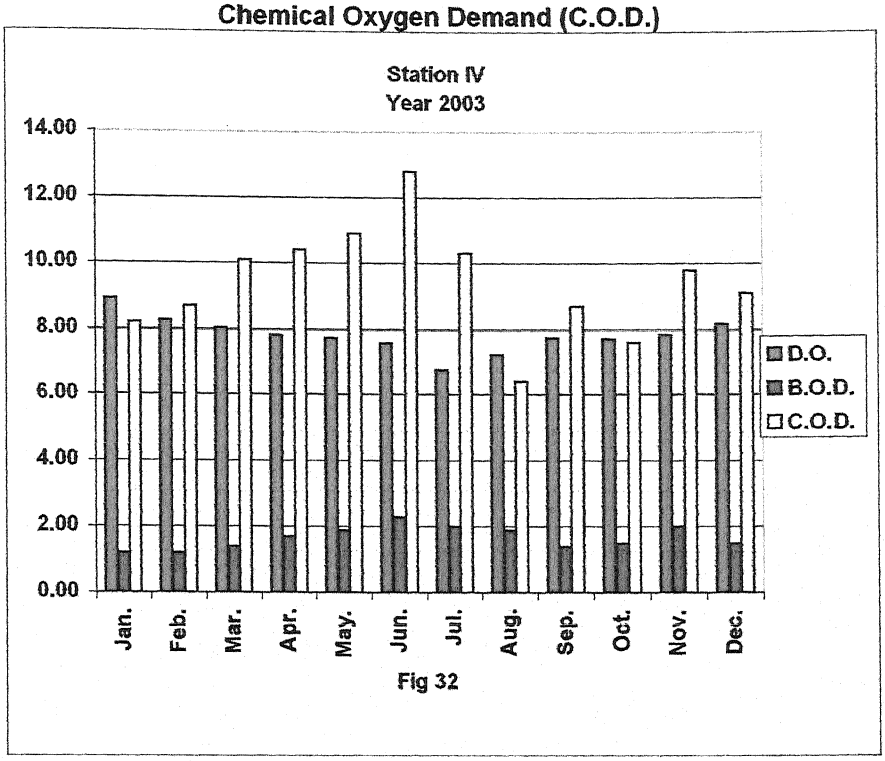


Fig 32

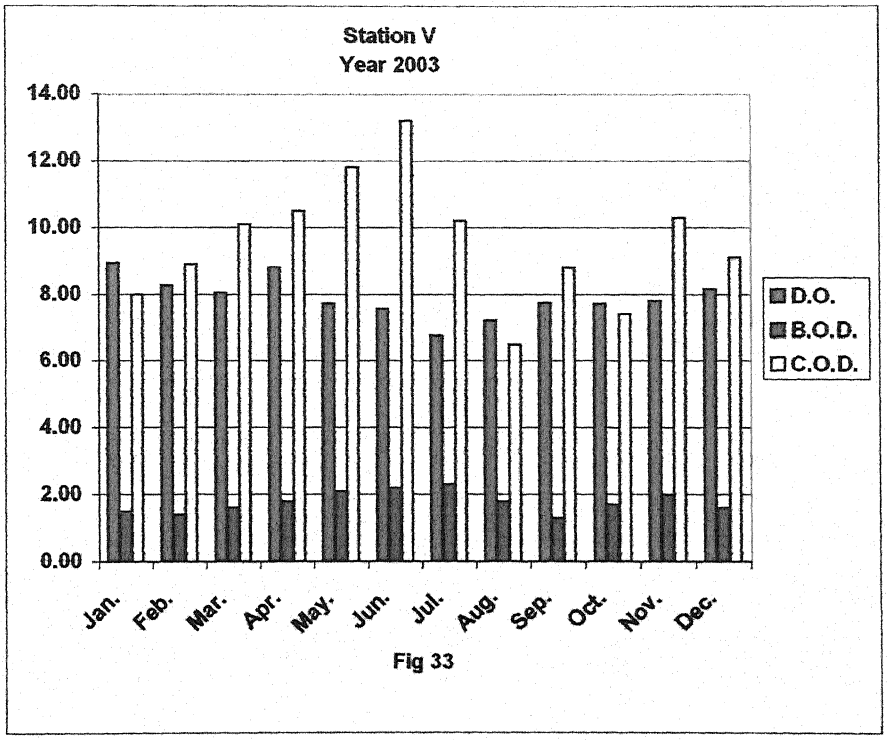


Fig 33

Ammonical nitrogen (NH_4N). Phosphate (Po_4) & Sulphate (So_4)

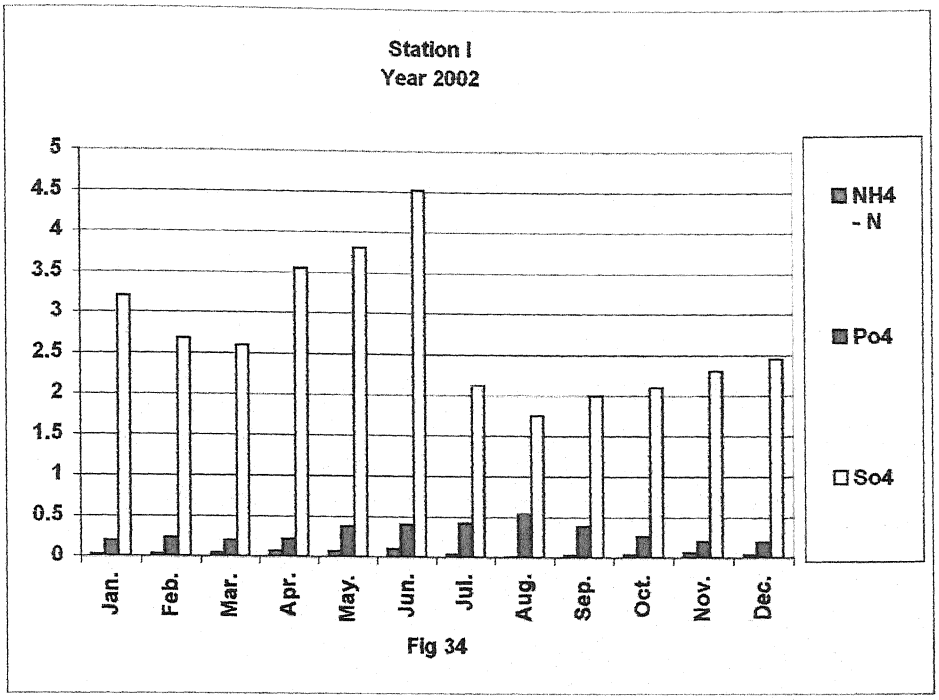


Fig 34

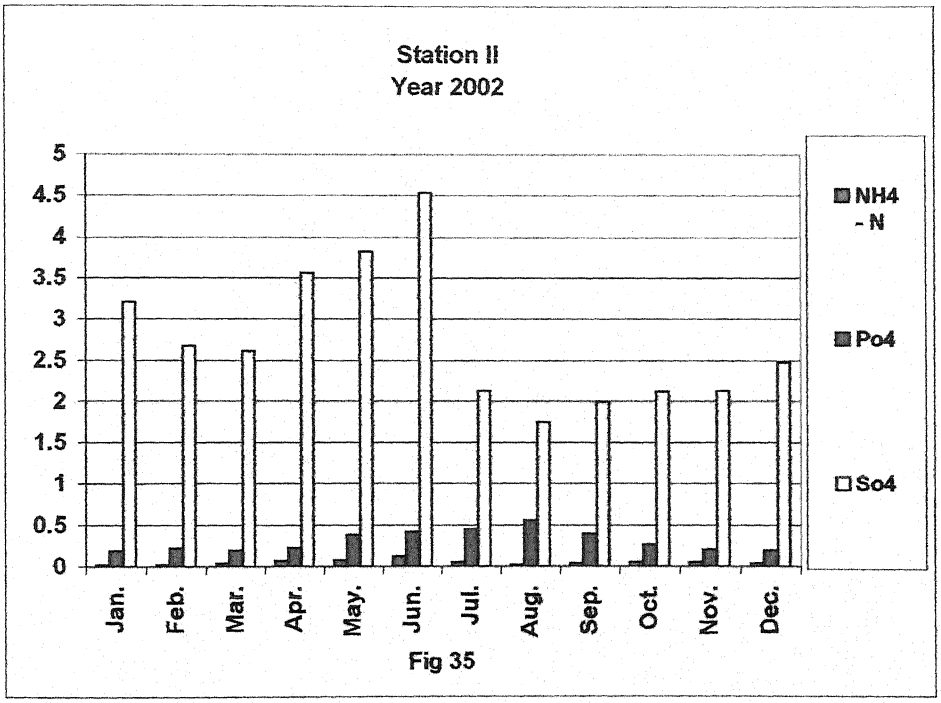


Fig 35

Ammonical nitrogen (NH_4N). Phosphate (Po_4) & Sulphate (So_4)

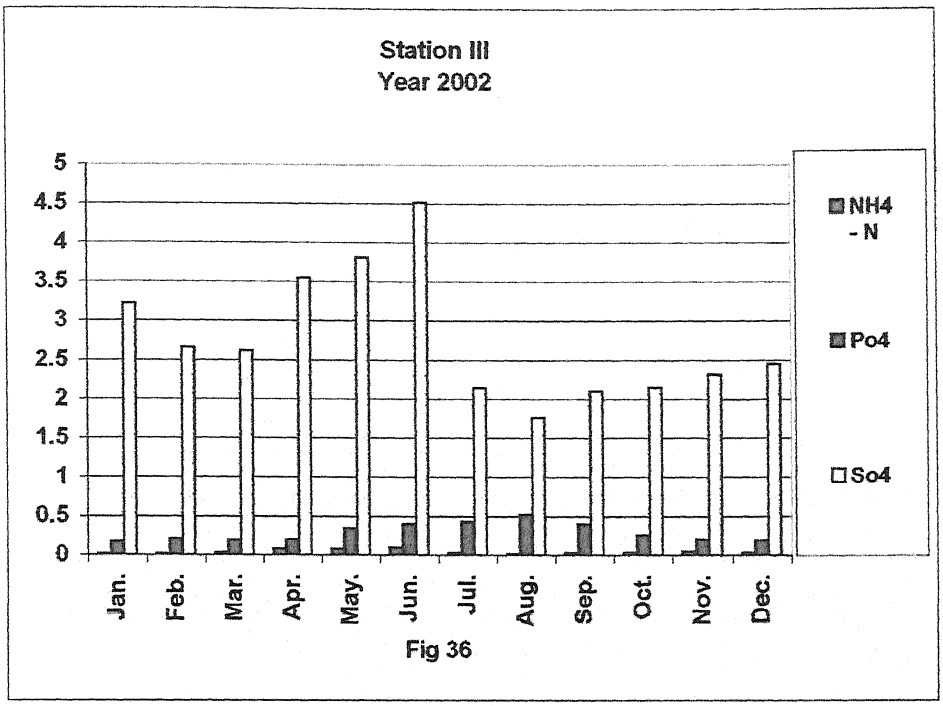


Fig 36

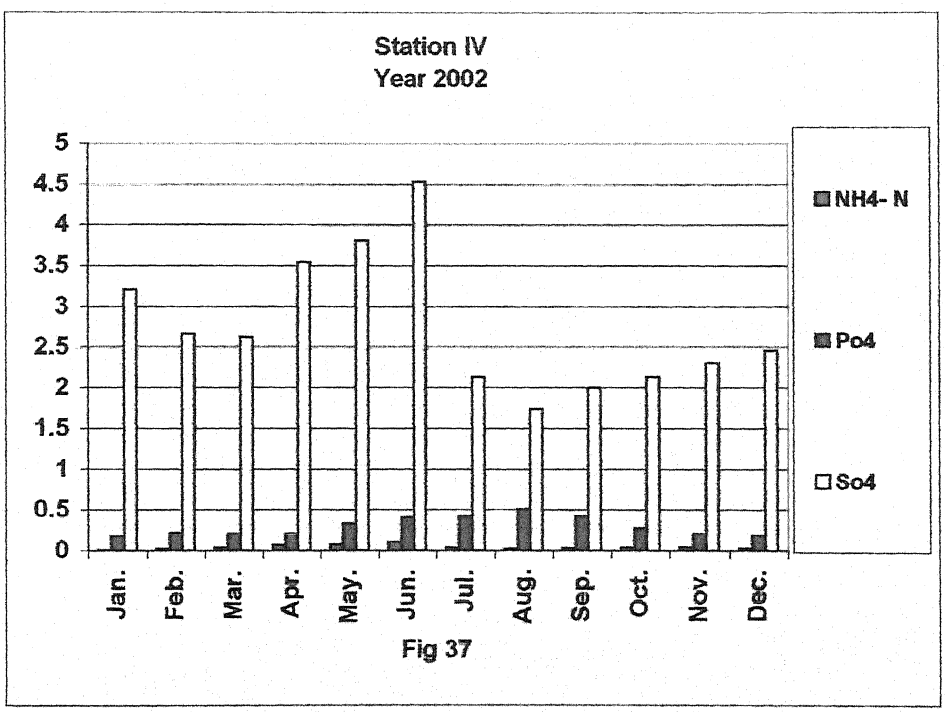


Fig 37

Ammonical nitrogen (NH_4N). Phosphate (Po_4) & Sulphate (So_4)

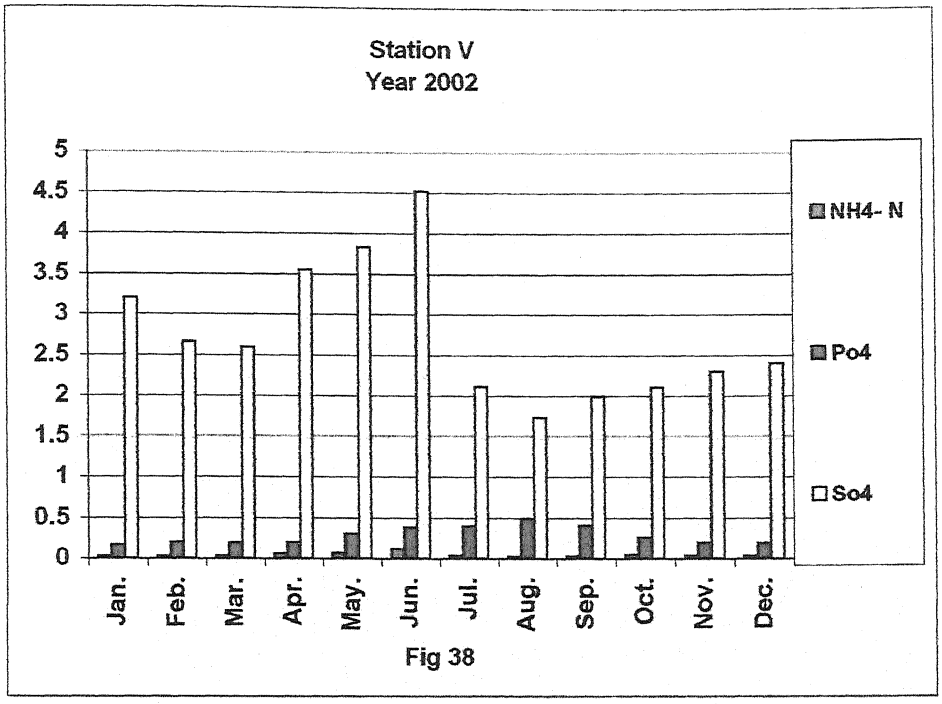


Fig 38

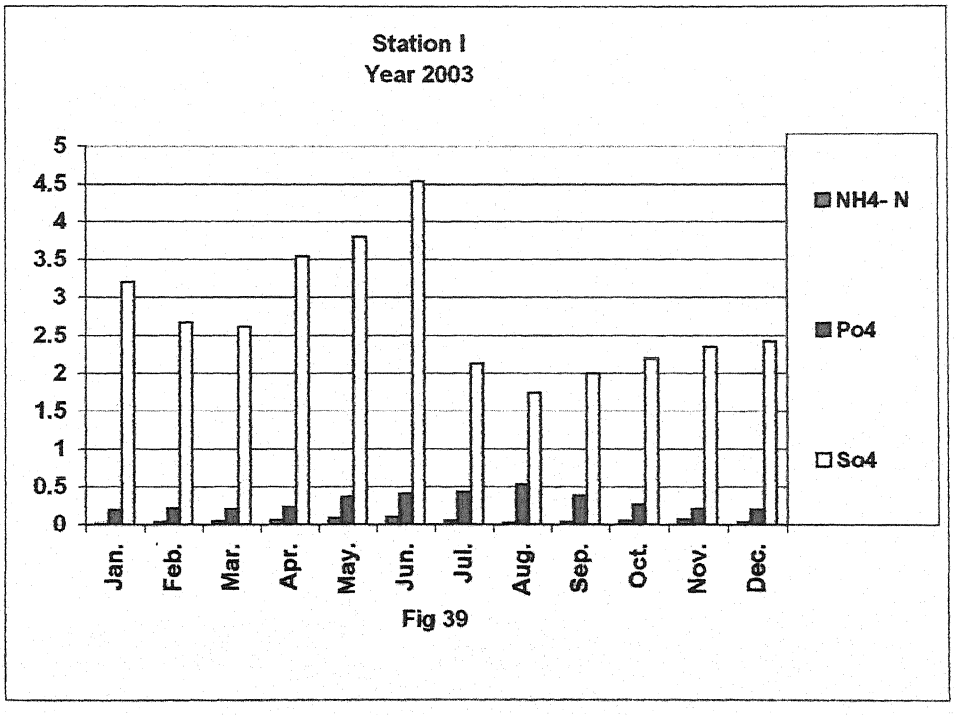


Fig 39

Ammonical nitrogen (NH_4N). Phosphate (Po_4) & Sulphate (So_4)

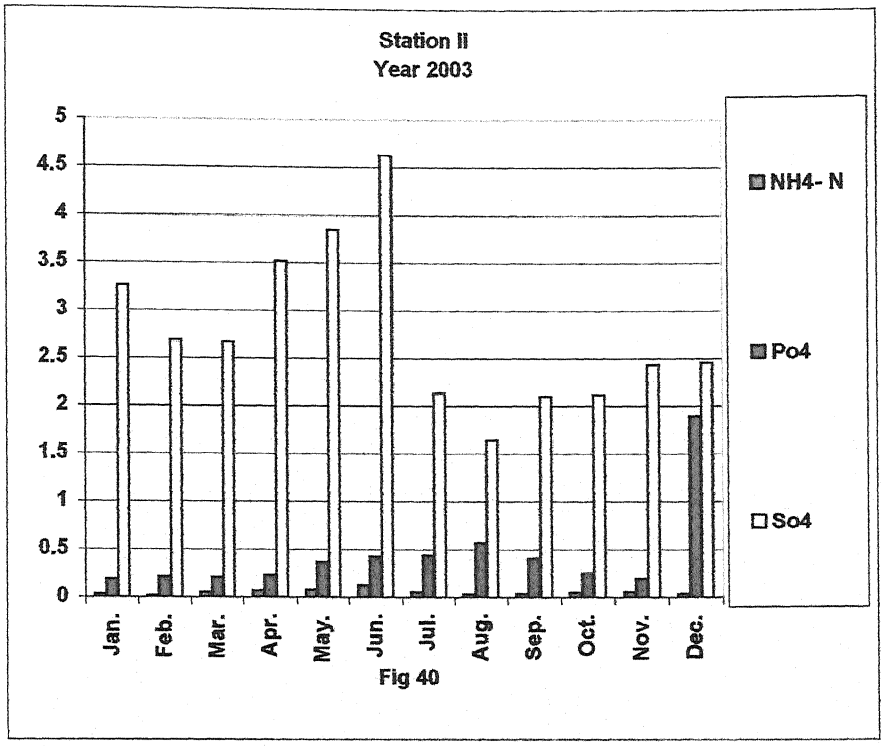


Fig 40

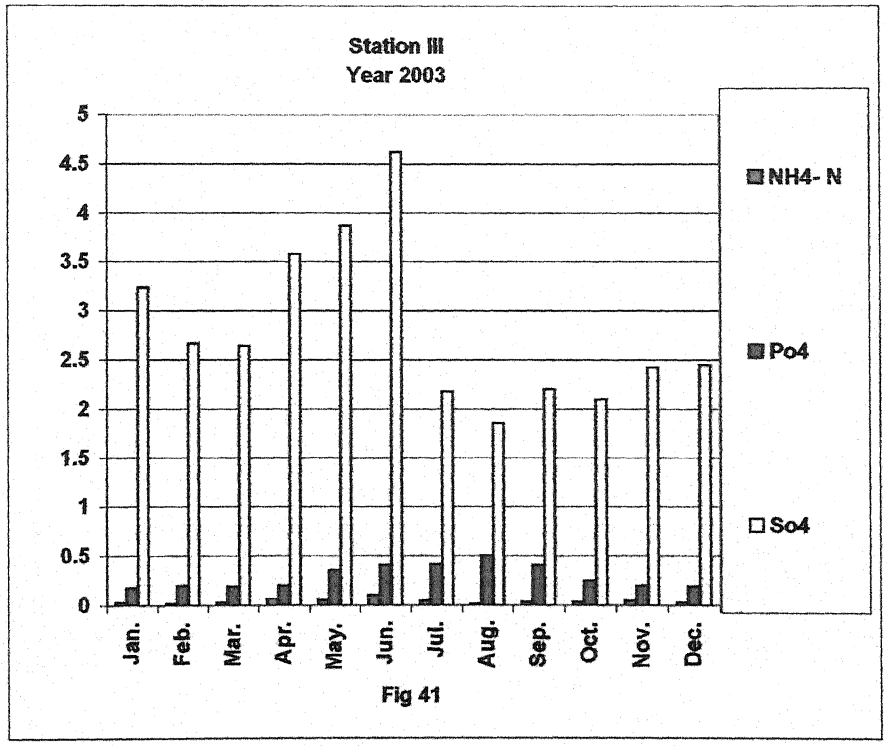


Fig 41

Ammonical nitrogen (NH_4N). Phosphate (Po_4) & Sulphate (So_4)

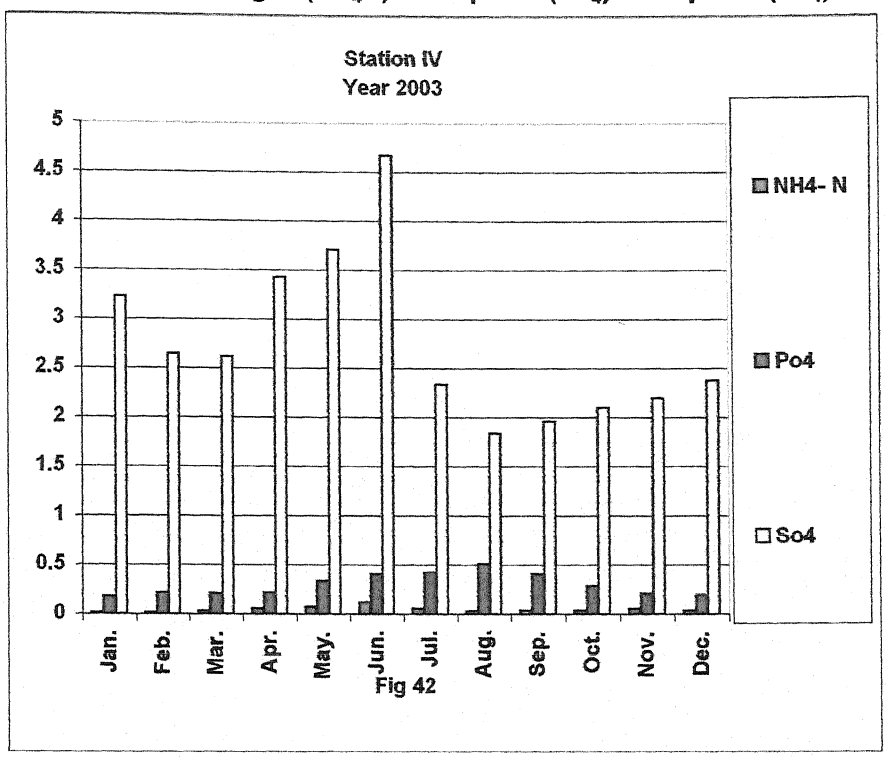


Fig 42

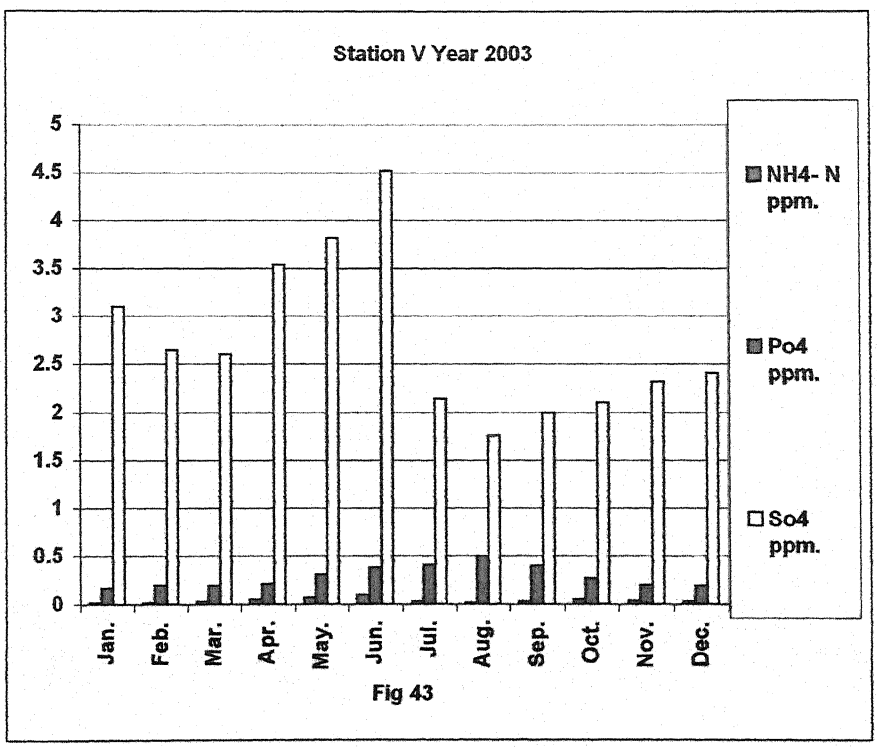


Fig 43

Water current, Carbon di oxide (co_2) & MPN

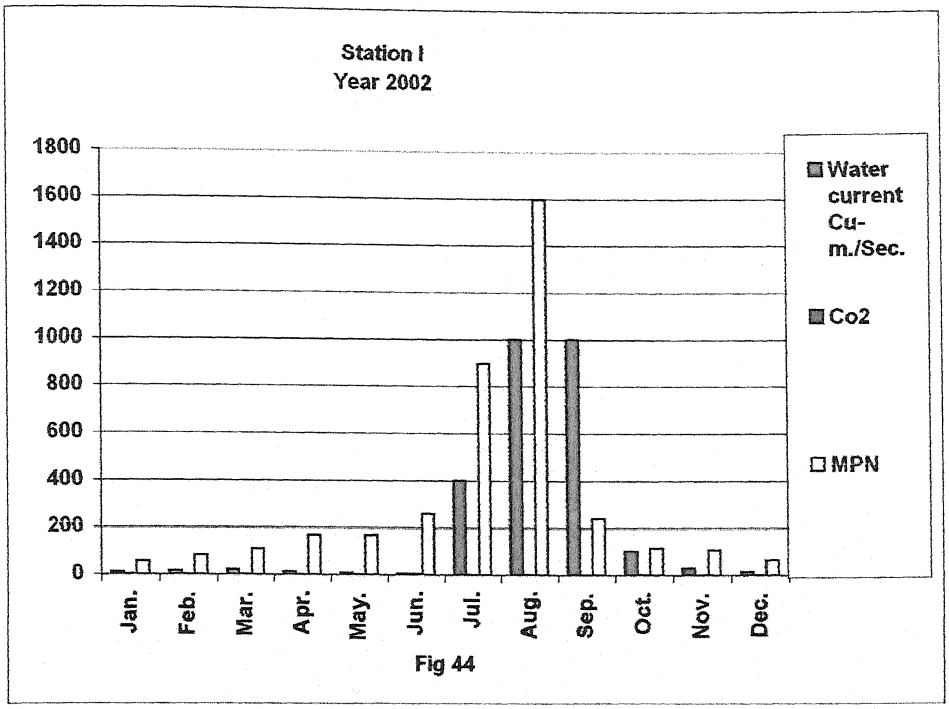


Fig 44

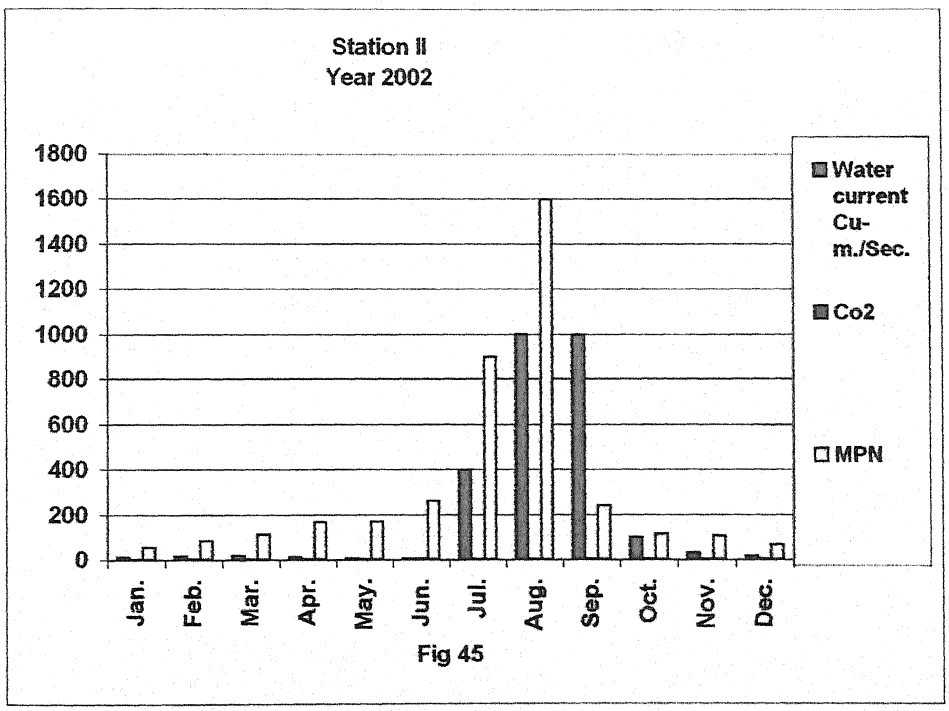


Fig 45

Water current, Carbon di oxide (co_2) & MPN

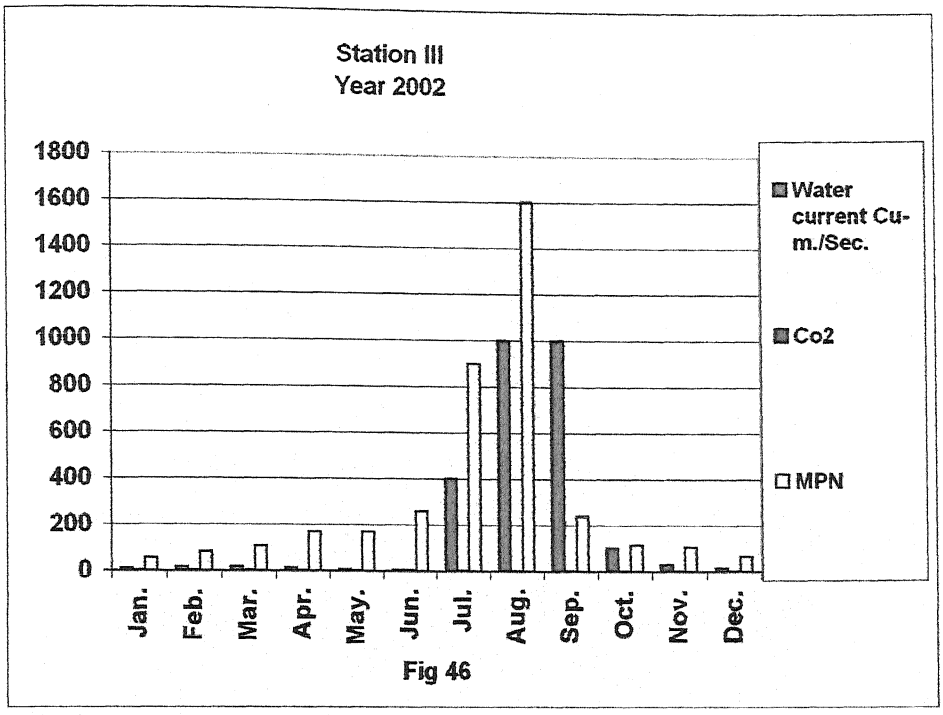


Fig 46

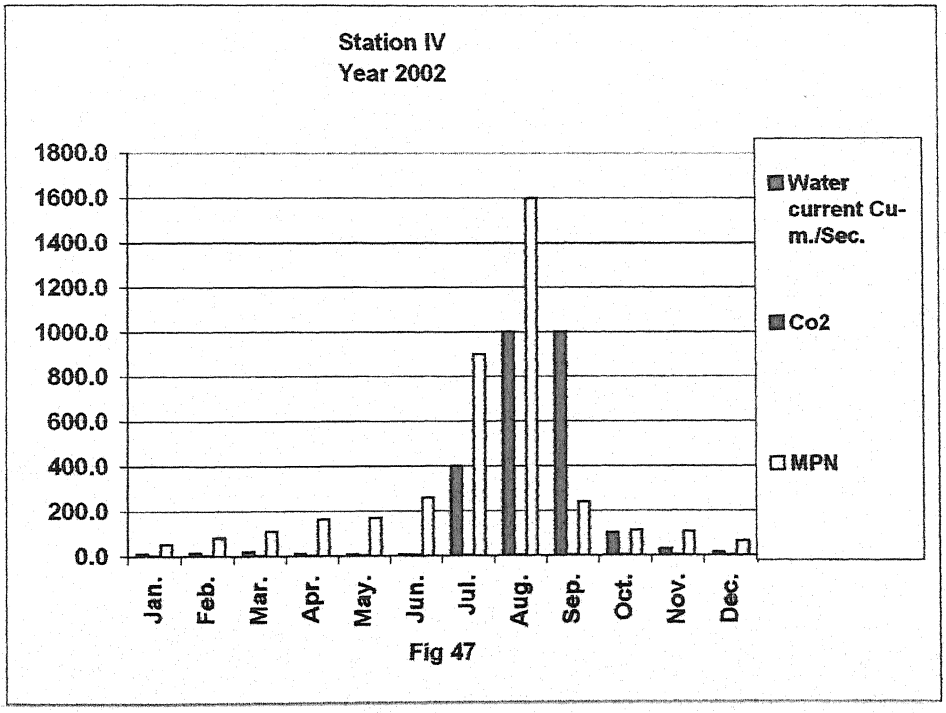


Fig 47

Water current, Carbon di oxide (co_2) & MPN

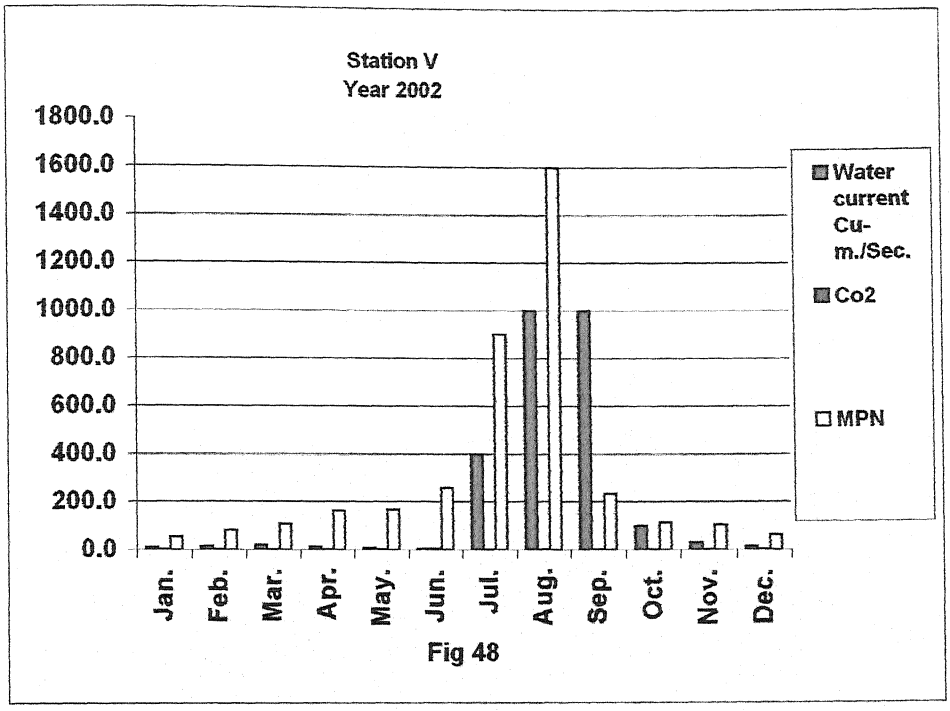


Fig 48

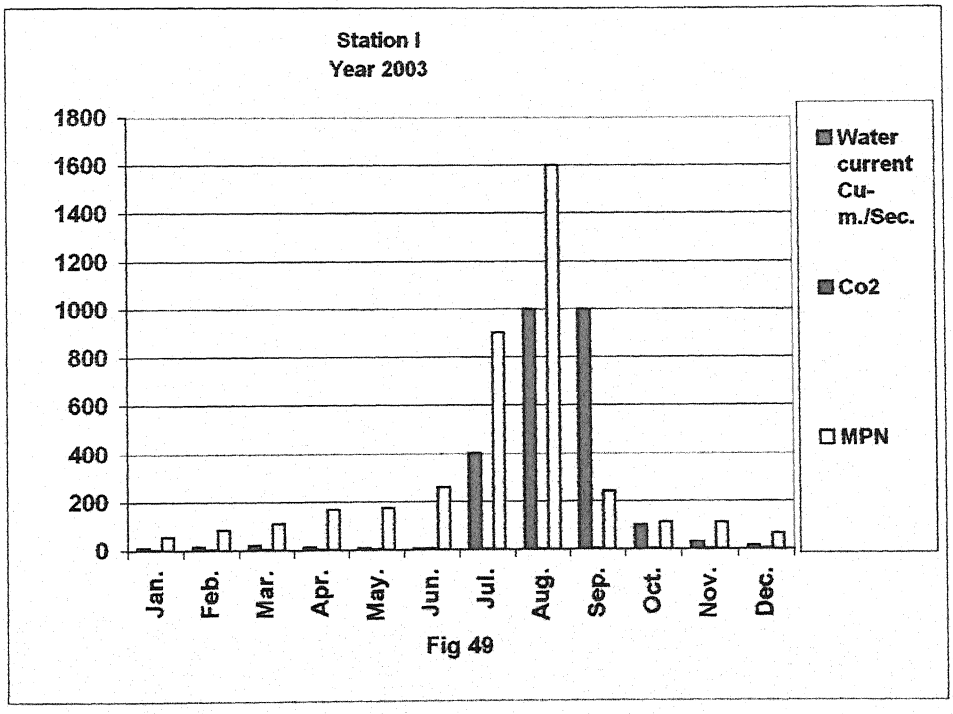


Fig 49

Water current, Carbon di oxide (co_2) & MPN

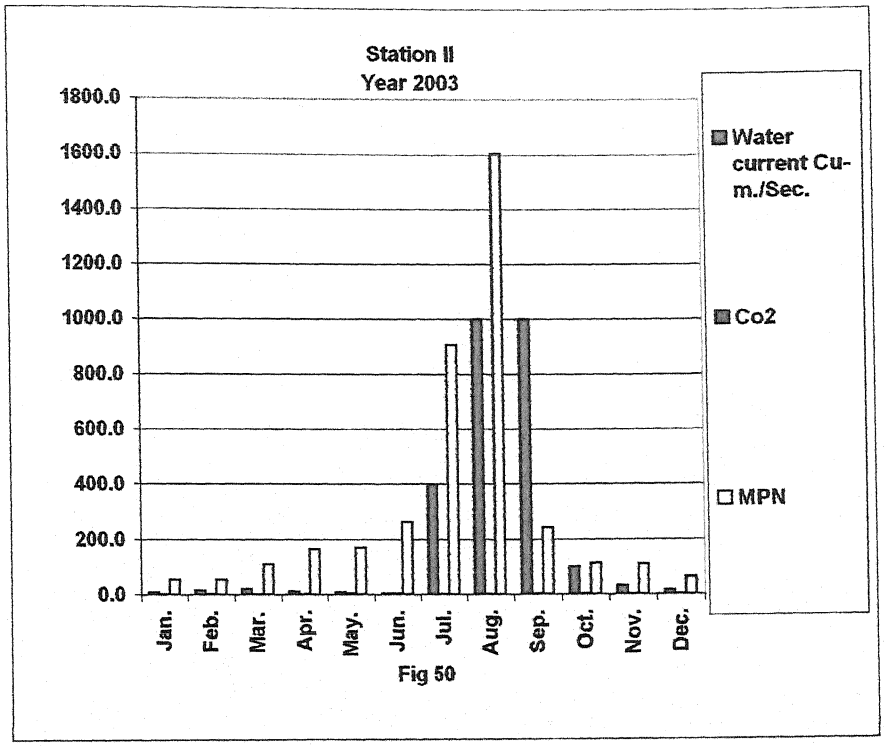


Fig 50

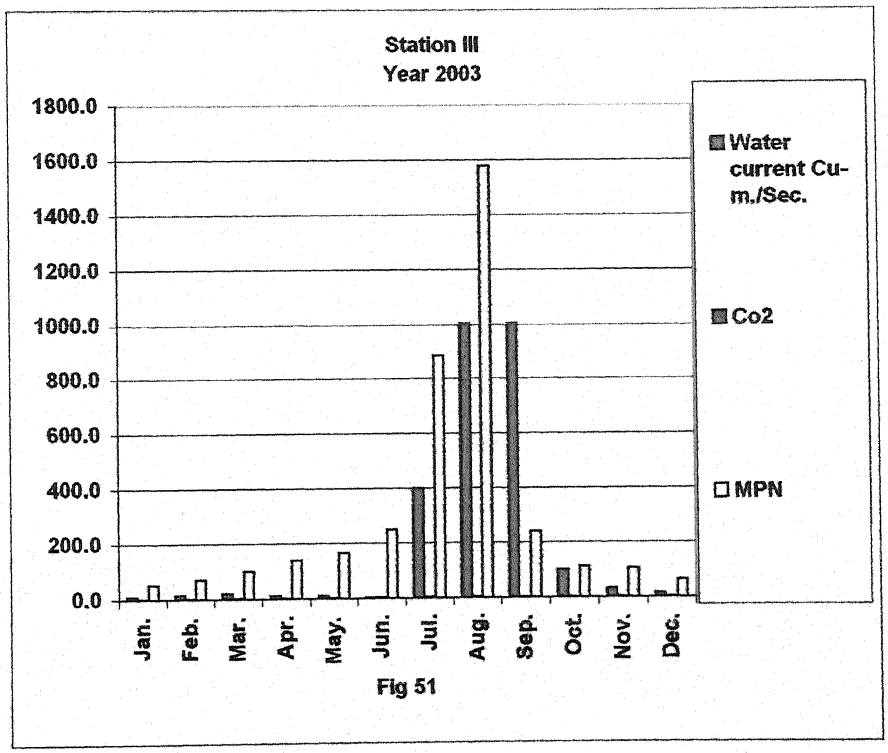
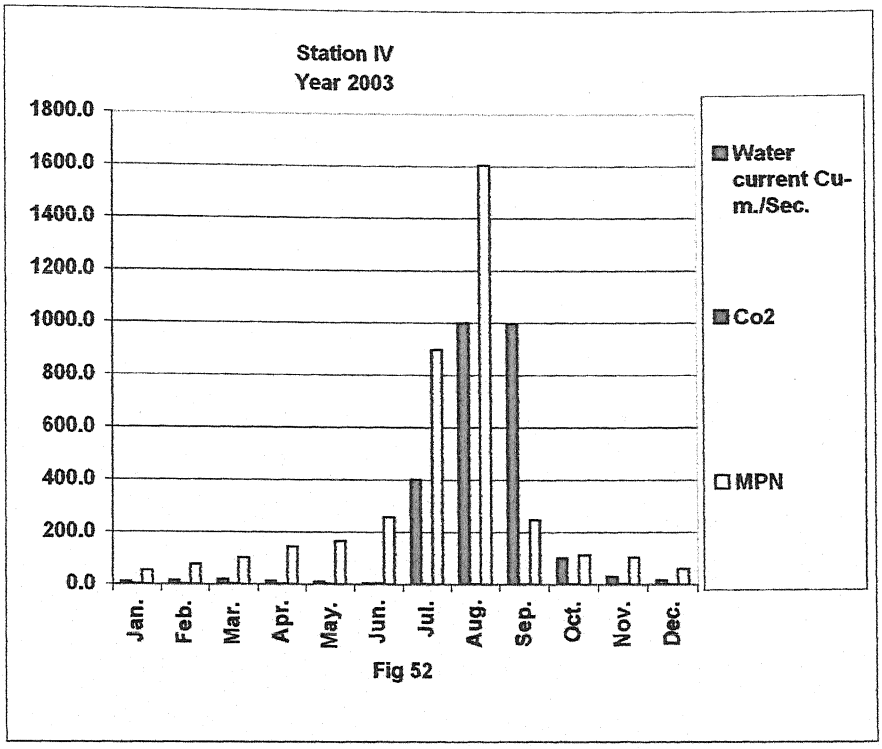


Fig 51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Year 2003
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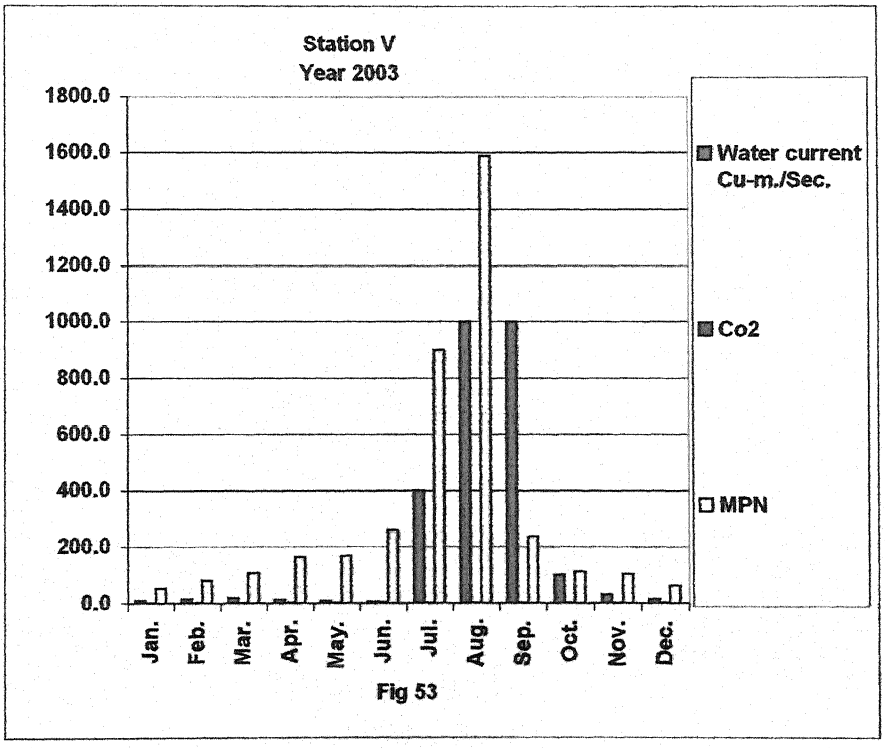
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Water current Cu-m./Sec.
Co2
MPN
Fig 52


Station V
Year 2003
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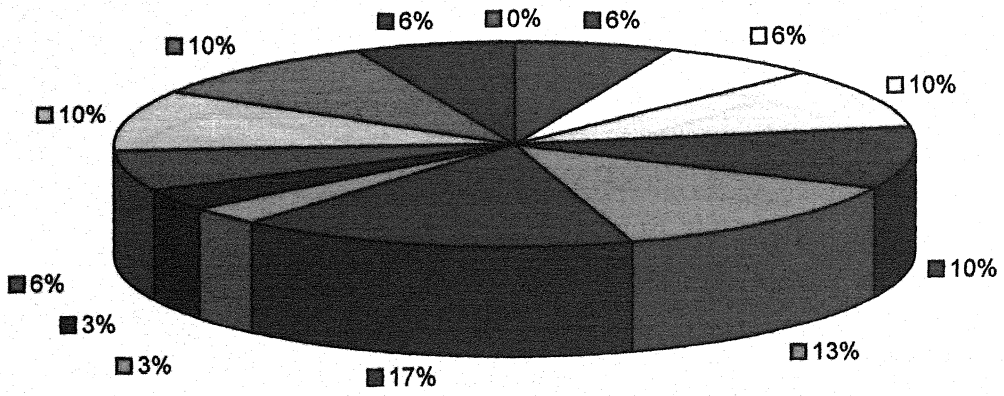
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Water current Cu-m./Sec.
Co2
MPN
Fig 53

Station I
Phytoplankton
2002



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 5 2 4 10 20 22 4 7 - 1 75 Jan - 3 2 15 1 16 5 6 2 2 2 - 54 Jan 4 50 2 - 1

Feb 6 3 6 8 12 20 3 6 2 2 68 Feb 2 4 3 12 2 8 4 6 2 2 4 - 49 Feb 4 58 2 - 2

Mar 8 6 10 6 14 18 1 9 8 - 80 Mar 4 6 4 10 15 6 4 4 4 4 5 4 70 Mar 5 46 4 - 2

Apr 12 8 12 10 16 19 1 7 7 - 92 Apr 8 6 6 18 19 5 3 4 4 4 5 5 87 Apr 6 38 4 - 2

May 12 8 13 12 13 22 - 18 14 - 112 May 8 8 12 9 26 14 - - 6 6 7 10 106 May 8 61 6 10 4

Jun 11 10 12 30 12 26 - 20 16 - 137 Jun 6 8 17 1 26 6 - - 13 10 9 15 111 Jun 10 68 9 25 2

Jul 4 2 6 - - 6 - 9 1 2 30 Jul - - - 20 1 1 1 - 2 - - - 25 Jul 1 43 - 6 -

Aug 3 2 5 3 - - - 7 - 2 22 Aug - - - 8 2 2 2 1 1 - - - 16 Aug 1 32 - 4 -

Sep 5 3 8 3 3 7 2 7 - 3 41 Sep 2 2 - 1 10 - 4 2 4 - 1 - 26 Sep 2 20 - 2 -

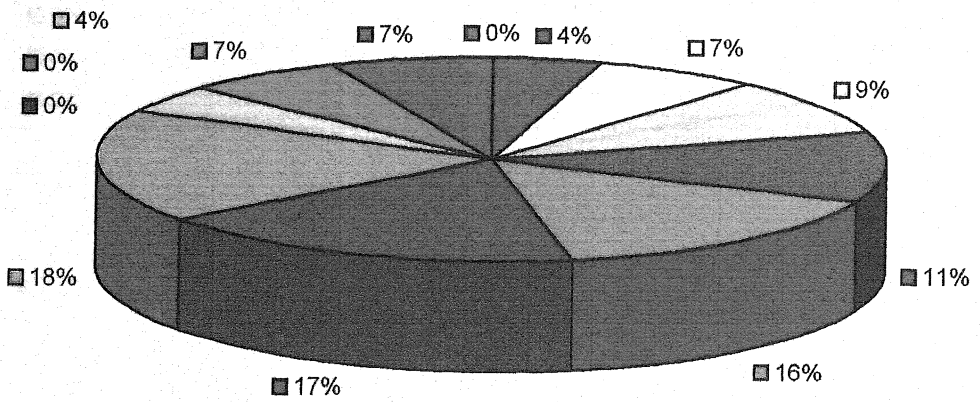
Oct 7 4 9 9 5 9 4 9 3 6 65 Oct 2 3 2 - 13 10 6 5 6 - 2 - 49 Oct 2 46 3 10 -

Nov 8 5 10 10 10 4 4 10 3 3 67 Nov 3 6 2 36 14 8 4 4 2 2 3 - 84 Nov 2 48 3 5 -

Dec 4 4 6 4 9 14 3 8 2 2 56 Dec 2 4 3 20 4 12 3 4 3 2 3 - 60 Dec 3 40 3 2 -

Fig 54

Station II
Phytoplankton
2002



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 4 2 4 10 19 20 3 6 - 1 69 Jan Jan - 4 16 4 17 5 6 2 4 2 - 60 Jan 4 50 2 - 1

Feb 6 2 5 8 12 20 3 6 3 3 68 Feb Feb 2 4 14 3 6 4 6 4 4 3 - 50 Feb 5 56 4 - 2

Mar 7 5 8 6 13 19 1 9 4 - 72 Mar Mar 5 6 9 16 6 4 4 6 6 5 4 71 Mar 6 47 6 - 3

Apr 10 7 12 8 16 19 1 9 6 - 88 Apr Apr 7 6 20 16 4 2 6 7 6 6 5 85 Apr 8 39 7 - 3

May 10 8 12 12 14 21 - 22 12 - 111 May May 7 7 9 23 15 - - 6 12 8 13 100 May 10 60 9 12 4

Jun 12 11 13 31 12 24 - 21 15 - 139 Jun Jun 6 6 1 24 6 - - 12 12 9 13 89 Jun 12 67 10 24 2

Jul 3 2 6 - - 5 - 8 1 2 27 Jul Jul - - 16 2 1 - - 6 - - - 25 Jul 1 43 - 5 -

Aug 3 2 5 2 - - - 7 - 2 21 Aug Aug - - 10 2 2 - - 1 - - - 15 Aug 1 32 - 4 -

Sep 4 5 7 3 4 6 2 8 - 4 43 Sep Sep 2 2 1 12 10 2 1 2 - - - 32 Sep 2 21 - 3 -

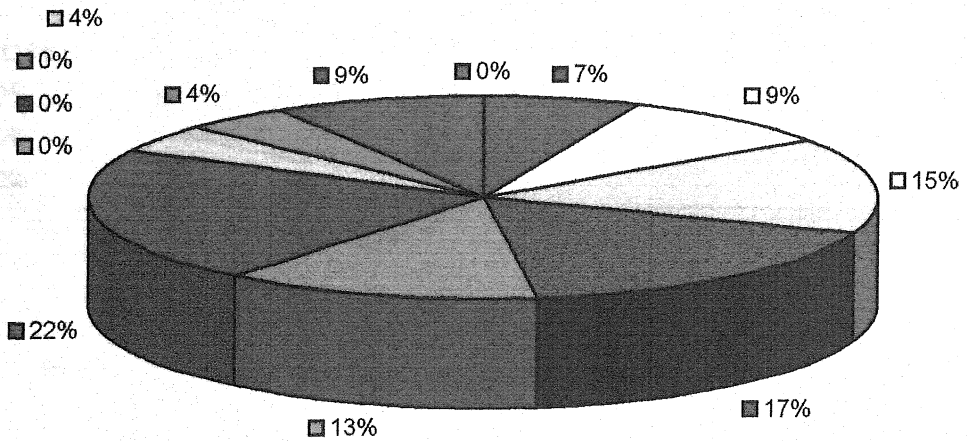
Oct 6 5 9 7 6 8 4 9 2 5 61 Oct Oct 4 3 - 12 14 6 2 4 - 2 - 47 Oct 4 45 2 10 -

Nov 8 6 11 10 9 4 3 10 3 6 70 Nov Nov 4 6 36 12 13 4 5 6 2 4 - 92 Nov 6 48 4 6 -

Dec 4 4 6 5 8 15 3 8 2 3 58 Dec Dec 2 4 18 13 14 3 4 8 2 5 - 73 Dec 7 40 3 2 -

Fig 55

Station III
Phytoplankton
2002



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 4 2 4 9 18 18 4 7 - 1 67 Jan - 4 14 4 16 6 6 4 6 2 - - 62 Jan 4 50 4 - 3

Feb 6 4 6 8 12 20 4 6 2 3 71 Feb 3 6 12 3 8 6 8 6 7 4 - - 63 Feb 6 55 4 - 6

Mar 6 5 8 6 13 22 1 8 4 - 73 Mar 4 6 11 16 6 4 9 7 6 5 3 4 81 Mar 7 46 8 - 7

Apr 12 6 10 8 15 22 1 7 7 - 88 Apr 6 8 16 15 5 8 10 6 8 7 6 5 100 Apr 9 32 9 - 7

May 12 8 12 10 13 26 - 19 12 - 112 May 8 6 8 23 14 10 - 8 12 8 12 13 122 May 10 60 9 10 6

Jun 13 12 12 28 12 24 - 20 15 - 136 Jun 8 8 2 26 5 - - 10 14 8 17 13 111 Jun 14 64 12 23 9

Jul 2 3 3 - - 2 - 9 4 2 25 Jul 2 1 20 2 2 - - 6 - - 3 - 36 Jul 1 42 1 5 -

Aug 1 2 2 1 - 1 - 7 - 2 16 Aug 1 2 7 2 2 - - 4 - - - - 18 Aug 2 31 - 4 -

Sep 4 6 8 3 3 4 2 6 - 4 40 Sep 2 3 1 10 - - 2 5 - - - - 23 Sep 3 21 - 2 -

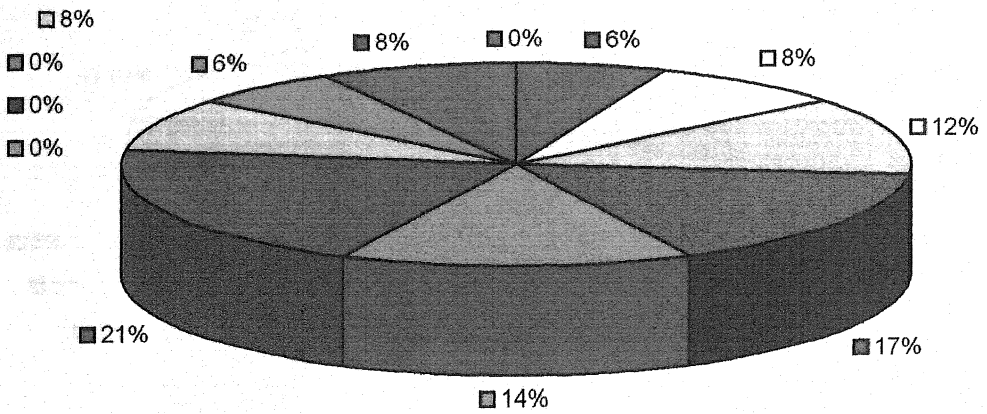
Oct 6 5 10 7 5 8 6 8 2 5 62 Oct 4 6 - 12 9 2 2 8 - - - - 43 Oct 6 44 4 10 -

Nov 6 6 12 8 9 14 6 10 3 6 80 Nov 6 4 36 13 8 6 6 6 2 2 - - 89 Nov 6 47 4 4 -

Dec 4 4 10 4 8 16 4 7 2 3 62 Dec 2 2 20 14 12 4 7 6 3 4 - - 74 Dec 5 39 4 2 -

Fig 56

Station IV
Phytoplankton
2002



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 2 2 4 8 18 17 4 6 - 1 62 Jan - 3 13 3 15 6 5 3 4 3 - - 55 Jan 4 50 3 - 4

Feb 5 4 6 8 10 19 6 6 2 3 69 Feb 4 5 12 4 7 8 7 5 6 4 - - 62 Feb 6 54 5 - 6

Mar 5 5 7 5 13 24 2 8 4 - 73 Mar 6 6 11 14 6 6 9 8 7 5 2 4 84 Mar 8 46 6 - 7

Apr 12 6 12 8 16 26 4 7 7 - 98 Apr 6 8 15 16 4 10 12 8 10 8 5 5 107 Apr 9 30 10 - 8

May 12 8 12 10 12 24 - 18 16 - 112 May 8 7 8 22 14 - - 10 12 10 10 13 114 May 10 60 10 10 8

Jun 14 12 14 26 12 25 - 20 14 - 137 Jun 9 10 2 25 5 - - 10 13 12 16 13 115 Jun 12 62 12 21 12

Jul 2 1 3 - - 2 - 8 4 2 22 Jul 2 2 20 2 2 - - 4 - - 2 - 34 Jul 2 40 1 4 -

Aug 1 2 1 1 - 4 - 7 - 2 18 Aug 2 1 6 1 2 - - 5 - - - - 17 Aug 1 30 - 4 -

Sep 4 4 8 2 3 6 2 6 - 4 39 Sep 3 4 1 8 - 2 2 9 - - - - 29 Sep 3 20 - 2 -

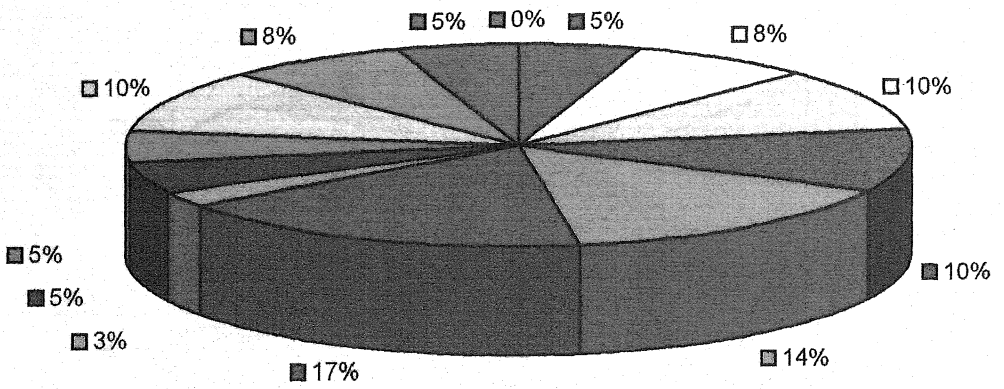
Oct 6 5 10 6 5 12 5 8 2 5 64 Oct 5 6 - 12 8 7 3 11 - - - - 52 Oct 5 43 - 10 -

Nov 5 6 11 6 8 14 6 10 3 7 76 Nov 6 4 33 14 8 3 6 9 4 - - - 87 Nov 5 46 3 3 -

Dec 4 4 6 4 7 10 4 7 2 3 51 Dec 2 2 19 6 12 4 4 7 3 2 - - 61 Dec 4 39 5 2 -

Fig 57

Station V
Phytoplankton
2002



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 2 3 3 7 19 18 4 5 - 1 62 Jan - 3 2 14 2 14 4 5 2 2 2 - 50 Jan 4 49 2 - 2

Feb 4 6 5 8 10 20 5 6 2 3 69 Feb 2 5 3 12 3 7 5 6 4 2 4 - 53 Feb 5 52 4 - 2

Mar 6 8 9 6 12 22 1 6 5 - 75 Mar 4 6 5 10 5 6 7 4 6 4 5 4 66 Mar 7 46 4 - 3

Apr 10 7 10 7 15 24 1 7 8 - 89 Apr 6 6 6 15 18 4 3 4 9 4 6 6 87 Apr 9 32 9 - 5

May 12 9 13 10 12 24 - 18 14 - 112 May 6 8 12 7 25 14 - - 11 7 8 10 108 May 12 60 12 9 6

Jun 14 11 13 24 13 26 - 20 16 - 137 Jun 8 8 16 3 28 5 - - 14 12 10 16 120 Jun 12 61 14 21 6

Jul 2 2 4 - - - - 8 1 1 18 Jul - - - 20 2 2 1 - 2 - - - 27 Jul 1 41 - 4 1

Aug 2 1 2 1 - 1 - 7 - 2 16 Aug - - - 5 1 2 2 1 1 - - - 12 Aug 2 28 - 4 2

Sep 4 3 6 2 3 5 4 6 - 3 36 Sep 1 2 - 1 10 - 4 2 4 - - - 24 Sep 2 20 - 1 -

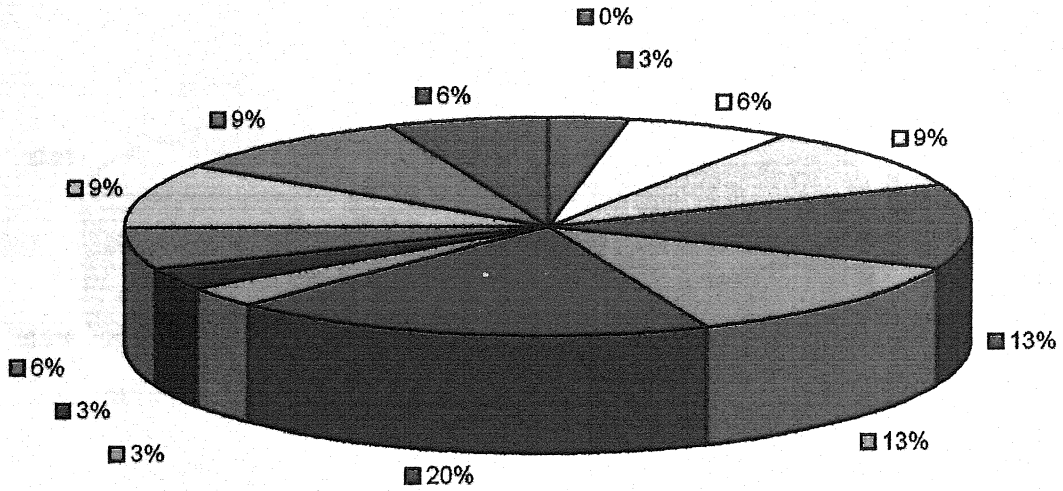
Oct 5 5 8 5 5 8 4 8 4 5 57 Oct 2 3 2 - 12 8 6 5 5 - - - 43 Oct 2 41 6 10 -

Nov 4 7 9 6 9 9 6 10 5 6 71 Nov 3 6 4 32 6 6 4 3 3 2 1 - 70 Nov 1 47 6 2 -

Dec 4 4 6 4 8 7 2 6 3 4 48 Dec 2 3 2 18 5 11 3 2 2 1 1 - 50 Dec 1 38 3 2 -

Fig 58

Station I
Phytoplankton
2003



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 5 2 4 11 19 20 4 7 - 1 73 Jan - 3 2 15 1 15 4 6 2 2 2 - 52 jan 4 52 2 - 1

Feb 6 4 6 8 13 22 5 6 - 2 72 Feb 3 4 4 13 2 8 6 5 3 2 4 - 54 feb 5 57 3 - 2

Mar 8 6 10 5 14 18 2 9 5 - 77 Mar 4 7 5 10 14 7 6 6 4 5 5 4 77 mar 6 46 4 - 4

Apr 12 8 13 10 15 19 2 6 7 - 92 Apr 7 7 6 17 16 4 3 - 6 6 5 6 83 apr 6 39 4 - 4

May 13 8 14 12 12 22 - 18 14 - 113 May 6 8 10 9 18 15 - - 6 6 7 10 95 may 8 61 7 10 6

Jun 13 10 6 31 11 26 - 21 14 - 132 Jun 8 8 16 1 24 6 - 1 12 10 9 16 111 jun 12 68 9 24 6

Jul 4 2 5 - - 6 - 9 1 1 28 Jul - - - 20 1 2 - 3 2 - - - 28 jul 1 43 - 6 -

Aug 3 1 7 3 - 2 - 7 - 2 25 Aug - - - 8 2 2 2 6 1 - - - 21 aug 1 32 - 5 -

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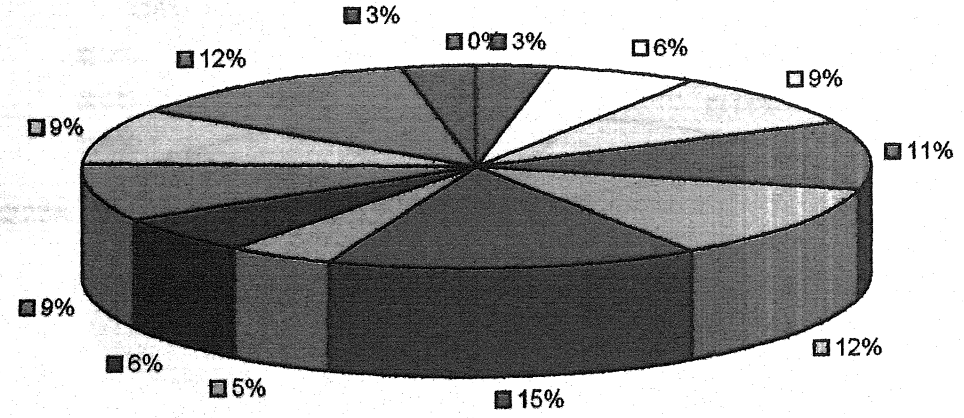
Oct 6 4 9 8 5 9 4 9 - 6 60 Oct 2 3 2 - 13 10 6 5 6 - 2 - 49 oct 3 45 2 10 -

Nov 8 6 10 10 10 10 4 11 1 3 73 Nov 4 6 6 36 16 8 4 6 6 3 4 - 99 nov 4 49 3 6 -

Dec 4 4 6 3 9 12 3 8 2 2 53 Dec 2 4 3 20 6 12 3 2 1 2 3 - 58 dec 3 41 2 2 -

Fig 59

Station II
Phytoplankton
2003



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 3 2 4 10 20 20 3 6 - 2 70 Jan - 4 16 3 17 4 6 2 4 2 - - 58 Jan 4 50 2 - 1

Feb 5 2 4 8 11 22 2 6 2 4 66 Feb 1 4 15 3 6 6 7 4 4 3 - - 52 Feb 4 55 4 - 2

Mar 7 5 6 6 13 18 1 8 4 - 68 Mar 2 7 9 15 6 5 8 6 7 6 4 4 79 Mar 6 46 5 - 4

Apr 11 7 13 8 15 20 1 9 10 - 94 Apr 6 7 20 16 5 2 9 8 7 8 6 6 100 Apr 8 40 6 - 4

May 12 10 14 12 15 21 - 22 12 - 118 May 7 6 9 22 15 - - 6 12 9 12 12 110 May 10 60 9 13 6

Jun 10 12 16 31 12 24 - 21 16 - 142 Jun 7 7 1 26 5 - - 7 12 - 14 14 93 Jun 12 68 12 24 -

Jul 2 2 4 - - 2 - 8 4 2 24 Jul 8 1 16 10 1 - - 4 - - - - 40 Jul 1 43 - 5 -

Aug 1 1 5 2 - 2 - 7 - 4 22 Aug - 2 10 2 2 - - 2 - - - - 18 Aug 2 32 - 4 -

Sep 4 5 7 4 4 4 2 8 - 5 43 Sep - 2 2 12 10 2 2 2 - 2 - - 34 Sep 2 22 - 3 -

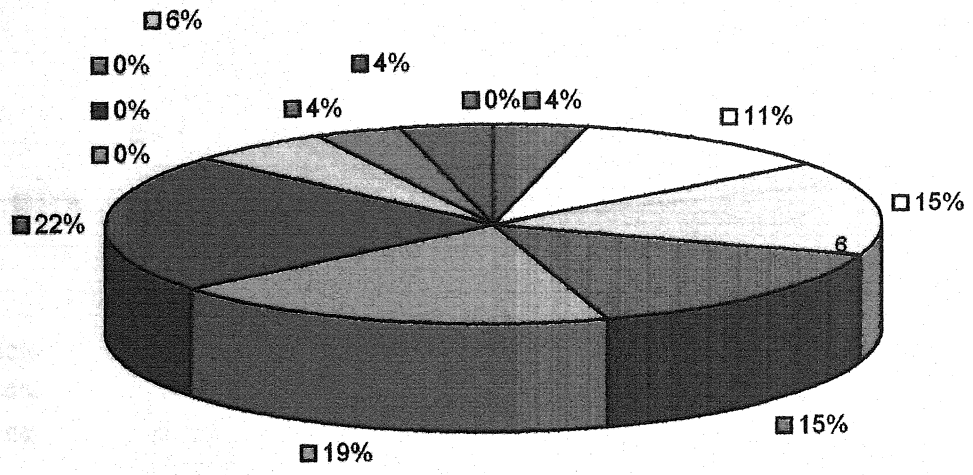
Oct 6 6 9 7 6 8 4 9 2 6 63 Oct 2 3 - 10 13 6 3 4 - 4 - - 45 Oct 6 46 2 10 -

Nov 7 6 10 10 10 9 3 10 3 7 75 Nov 4 6 36 12 13 4 4 6 3 5 - - 93 Nov 8 48 6 6 -

Dec 4 4 6 5 8 6 2 8 6 3 52 Dec 2 4 18 4 14 3 6 4 2 6 - - 63 Dec 6 40 3 1 -

Fig 60

Station III
Phytoplankton
2003



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 4 2 3 9 17 16 3 6 - 1 61 Jan - 3 15 3 17 3 3 2 5 - 3 - 54 Jan 3 50 4 - 2

Feb 5 3 5 8 13 22 4 6 2 4 72 Feb 3 5 12 4 8 6 9 5 7 3 - - 62 Feb 5 55 4 - 8

Mar 7 6 9 6 13 22 2 9 4 - 78 Mar 6 5 11 10 6 4 10 10 8 6 3 4 83 Mar 7 46 6 - 9

Apr 10 9 12 7 15 25 1 7 7 - 93 Apr 6 8 17 15 5 8 10 10 10 8 5 6 108 Apr 10 32 10 -

May 12 13 12 11 13 26 - 19 13 - 119 May 9 10 9 22 14 12 - - 12 8 12 12 120 May 1 60 10 9 12

Jun 14 14 12 29 12 26 - 20 16 - 143 Jun 10 8 2 24 5 - - - 16 - 16 14 95 Jun 1 64 12 23 4

Jul 2 1 1 - - 2 - 9 4 3 22 Jul 2 1 20 2 2 - - - - - 3 - 30 Jul 2 43 1 4 -

Aug 1 1 - 2 - - - 7 - 2 13 Aug 1 2 6 1 2 - - - - - - - 12 Aug 4 31 - 4 -

Sep 4 5 6 3 3 8 2 6 - 4 41 Sep 3 4 1 10 - - 2 2 - - - - 22 Sep 5 20 - 2 -

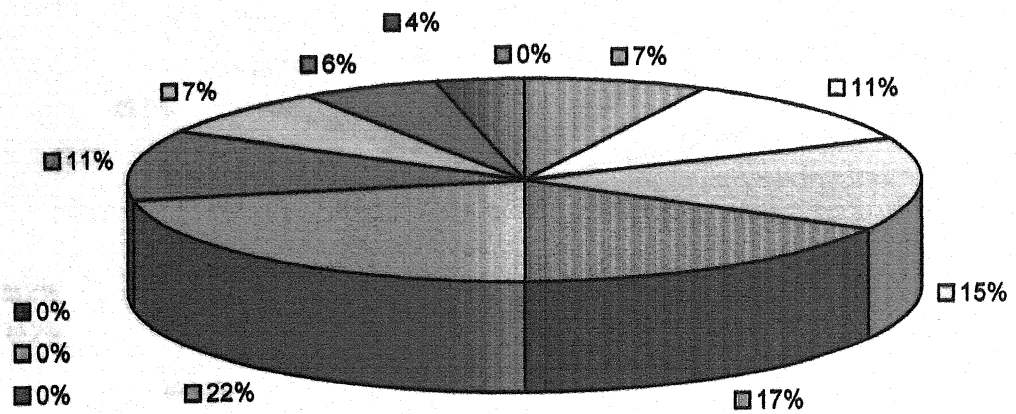
Oct 5 4 6 7 5 10 5 8 2 5 57 Oct 4 4 - 13 8 2 2 4 - - - - 37 Oct 6 44 3 10 -

Nov 7 6 7 8 8 12 6 10 3 7 74 Nov 5 6 37 13 8 6 5 6 3 2 - - 91 Nov 6 46 4 3 -

Dec 5 3 4 4 8 10 4 6 2 3 49 Dec 2 3 20 10 12 3 3 5 3 3 - - 64 Dec 4 40 4 2 -

Fig 61

Station IV
Phytoplankton
2003



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 4 3 3 9 18 16 3 6 - 1 63 Jan - 2 13 4 15 5 4 5 3 2 - - 53 Jan 4 50 3 - 5

Feb 5 5 7 8 9 18 5 6 2 2 67 Feb 3 5 13 6 6 8 7 4 6 5 - - 63 Feb 10 54 7 - 7

Mar 8 6 7 6 13 22 7 7 3 - 79 Mar 6 6 11 12 6 9 10 7 8 6 4 4 89 Mar 10 45 8 - 8

Apr 14 8 14 8 15 25 62 7 6 - 161 Apr 8 8 15 15 4 9 10 8 10 10 6 6 109 Apr 12 30 10 - 8

May 14 10 14 10 12 24 - 18 12 - 114 May 10 8 7 20 14 - 6 12 14 14 12 12 129 May 11 60 12 10 12

Jun 16 12 14 26 13 26 - 20 16 1 144 Jun 12 10 2 22 5 - - 11 - - 18 14 94 Jun 11 62 12 21 14

Jul 2 3 2 - - 2 - 7 12 2 30 Jul 2 2 20 2 2 - - 3 - - 2 - 33 Jul 1 40 1 5 -

Aug 1 3 2 2 - 1 - 7 4 4 24 Aug 2 1 7 2 2 - - 2 - - 1 - 17 Aug 2 30 - 4 -

Sep 4 5 6 2 3 5 2 6 - 5 38 Sep 7 4 1 6 - 2 3 8 - - - - 31 Sep 4 20 - 2 -

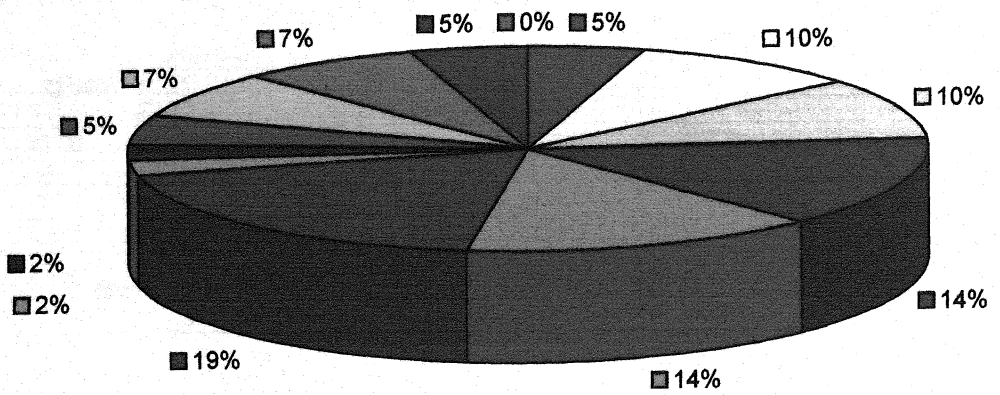
Oct 7 6 8 7 6 10 5 8 - 6 63 Oct 5 6 - 10 8 6 4 11 - - - - 50 Oct 6 43 2 10 -

Nov 8 7 10 6 8 12 7 10 2 7 77 Nov 6 3 33 14 8 4 4 11 4 5 - - 92 Nov 5 46 3 3 -

Dec 5 4 6 4 7 8 4 6 3 5 52 Dec 3 2 19 6 12 3 2 6 3 4 - - 60 Dec 3 40 2 2 -

Fig 62

Station V
Phytoplankton
2003



Chlorella Microshpora Pandorina Pediastrum Ulothrix Spirogyra Zygnema Scenedesmus Volvox Eudorina Astorionella Cyclotella Diotoma Navicula Synebra Nitzschia Melosira Pinnularia Tabellaria Amphipleura Fragilaria Cymbella Anabaena Microcysits Nostoc

Jan 1 2 4 7 13 16 3 6 - 2 54 Jan - 2 2 14 2 15 4 4 2 2 2 - 49 Jan 3 49 2 - 2

Feb 3 5 5 8 15 18 5 6 2 3 70 Feb 2 4 3 12 3 7 3 6 3 3 4 - 50 Feb 4 52 4 - 2

Mar 5 6 9 6 16 20 1 8 4 - 75 Mar 3 5 4 10 4 6 5 4 5 4 6 4 60 Mar 6 46 5 - 4

Apr 9 6 10 7 19 22 1 7 6 - 87 Apr 5 4 6 15 16 4 6 3 9 4 6 5 83 Apr 8 32 6 - 5

May 10 9 10 10 13 22 - 18 8 - 100 May 5 6 10 7 22 14 3 - 10 6 8 10 101 May 12 60 10 8 6

Jun 12 10 12 24 11 24 - 20 12 - 125 Jun 8 - 14 3 26 5 - - 12 10 10 15 103 Jun 16 61 16 21 7

Jul 1 2 2 - - 2 - 8 3 1 19 Jul - - - 20 2 2 - - 1 - - - 25 Jul 1 41 - 4 2

Aug 1 1 2 1 - - - 7 2 2 16 Aug - 2 - 5 1 2 - 1 2 - - - 13 Aug 2 28 - 3 2

Sep 3 4 6 2 4 4 3 6 - 3 35 Sep 1 2 - 1 10 - - 1 5 - - - 20 Sep 3 20 - 1 -

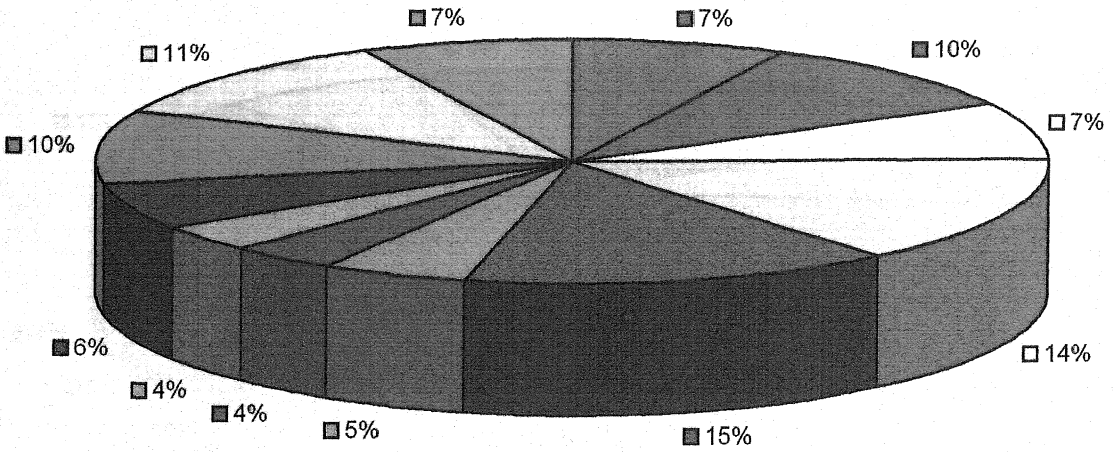
Oct 3 5 9 5 8 8 4 8 - 4 54 Oct 3 5 2 - 10 8 4 2 4 - - - 38 Oct 3 41 5 10 -

Nov 4 6 8 6 11 8 6 10 3 4 66 Nov 2 6 3 32 12 6 5 3 3 2 2 - 76 Nov 1 46 5 3 -

Dec 3 5 4 4 11 6 3 6 4 6 52 Dec 3 4 1 18 6 11 4 3 2 1 2 - 55 Dec 1 35 3 2 -

Fig 63

Station I
Zooplankton
2002



Jan 1 3 - 1 1 1 4 11 3 18 - - 2 23 1 5 7 1 2 16 5 -

Feb 2 3 - 2 1 6 8 22 6 6 3 - 6 21 2 10 20 2 8 42 6 -

Mar 4 5 - 3 2 12 8 34 16 10 2 - 6 34 2 13 26 8 9 58 7 -

Apr 5 6 2 4 3 15 13 48 19 16 1 - 10 46 4 24 32 6 10 76 25 10

May 7 8 4 6 4 16 16 61 18 20 6 - 12 56 6 22 47 6 12 93 30 6

Jun 9 12 6 10 6 18 18 79 20 21 4 6 15 66 8 14 9 6 8 45 20 4

Jul 1 1 - - - - - 2 1 3 2 4 2 12 1 4 - - 6 11 22 -

Aug 1 1 - - - - - 2 - 1 2 4 2 9 1 3 - - 2 6 4 -

Sep 2 3 - - 1 2 2 10 8 5 3 2 4 22 2 1 - 1 3 7 5 4

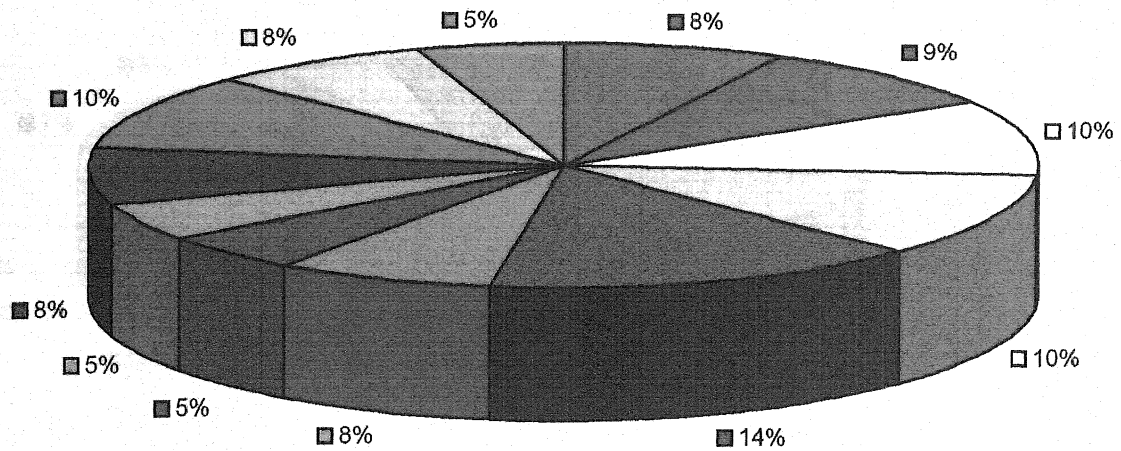
Oct 2 4 - 2 1 4 4 17 14 8 10 14 6 52 4 3 10 2 4 23 14 16

Nov 3 5 - 2 - 6 6 22 16 14 1 2 5 38 4 5 10 2 6 27 32 14

Dec 2 2 - 1 - - 3 8 2 15 - - 4 21 2 2 12 1 5 22 35 -

Fig 64

Station II
Zooplankton
2002



Jan 2 3 - 2 1 1 3 12 4 17 - - 4 25 2 6 6 2 3 19 6 -

Feb 2 4 - 2 2 6 7 23 10 6 3 - 5 24 2 9 21 2 6 40 5 -

Mar 4 4 - 4 4 13 7 36 16 11 2 - 5 34 5 12 25 7 10 59 7 -

Apr 6 5 3 6 4 15 12 51 21 15 2 - 10 48 5 24 38 8 10 85 26 10

May 7 7 6 7 5 17 14 63 22 20 6 - 14 62 8 22 49 8 10 97 30 5

Jun 9 11 6 12 6 19 15 78 22 22 4 7 16 71 1 15 6 9 12 43 19 4

Jul 2 2 - - - - 18 22 3 3 2 4 2 14 1 3 - - 3 7 22 -

Aug 1 2 - - - - 16 19 2 1 2 3 1 9 3 3 - - 2 8 4 -

Sep 2 3 - - 2 3 6 16 8 4 3 2 4 21 5 1 - 1 4 11 4 3

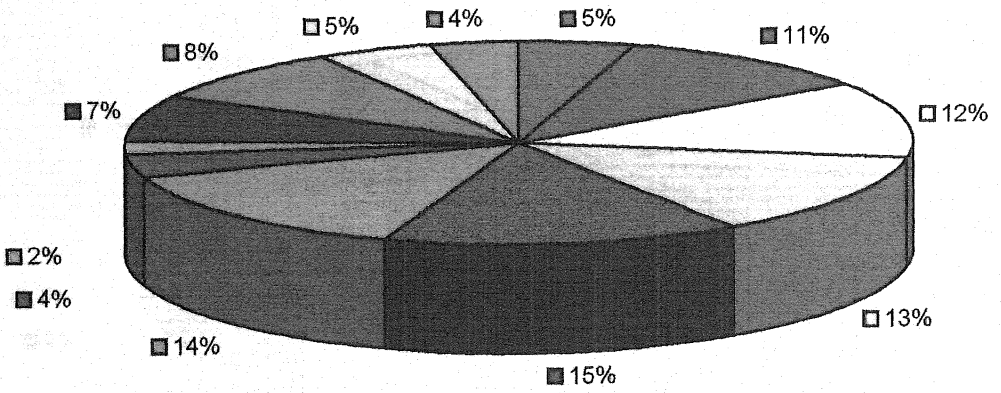
Oct 2 5 - - 3 6 3 19 12 8 10 15 6 51 5 3 6 3 6 23 15 16

Nov 3 5 - 2 - 6 7 23 16 14 1 2 4 37 6 5 15 4 5 35 32 13

Dec 2 2 - 2 - - 3 9 3 16 - - 4 23 3 2 12 3 3 23 33 -

Fig 65

Station III
Zooplankton
2002



Jan 3 2 - 2 1 2 2 12 4 15 5 2 4 30 3 2 6 3 2 16 5 - 5 5 4 19 77 Jan 3 2 - 3 2 3 2 15 3 15 - - 3 21 2 5 7 2 3 19 4 -

Feb 3 3 - 3 3 5 6 23 10 5 6 4 5 30 3 2 20 3 4 32 5 - 8 5 3 21 106 Feb 4 4 - 3 3 6 4 24 6 6 3 - 5 20 3 10 20 2 4 39 6 -

Mar 5 4 - 5 4 10 6 34 16 10 12 6 5 49 6 3 25 9 10 53 7 - 9 10 4 30 166 Mar 6 5 - 6 4 10 5 36 16 11 2 - 6 35 4 12 25 8 7 56 8 -

Apr 5 8 4 6 4 12 10 49 22 15 14 10 12 73 6 4 33 9 10 62 26 9 9 10 4 58 242 Apr 6 9 4 6 6 13 8 52 20 17 2 - 13 52 8 24 32 10 9 83 24 10

May 7 10 7 6 6 14 14 64 25 20 16 14 14 89 6 6 47 10 12 81 30 6 10 10 3 59 293 May 8 10 6 7 6 16 10 63 26 19 6 - 16 67 7 22 47 12 10 98 30 7

Jun 10 12 6 10 8 18 16 80 25 21 18 15 15 94 3 6 6 12 12 39 19 4 9 12 2 46 259 Fig 66 Jun 11 10 6 11 8 19 14 79 28 22 3 6 18 77 3 14 9 12 14 52 18 4

Jul 2 1 - - - - 18 21 2 2 18 2 2 26 2 2 - - 3 7 21 - 3 3 - 27 81 Jul 2 2 - - - - 12 16 3 3 2 4 4 16 2 4 - - 3 9 22 -

Aug 1 2 - - - - 16 19 6 1 - 3 2 12 1 1 - - 2 4 4 - 2 3 - 9 44 Aug 1 1 - - - - 16 18 3 1 2 5 3 14 1 3 - - 1 5 4 -

Sep 3 2 - - 2 2 5 14 10 5 - 5 4 24 4 2 - 2 5 13 4 4 17 6 3 34 85 Sep 4 3 - - 3 3 6 19 10 4 3 2 5 24 3 1 - 2 6 12 6 4

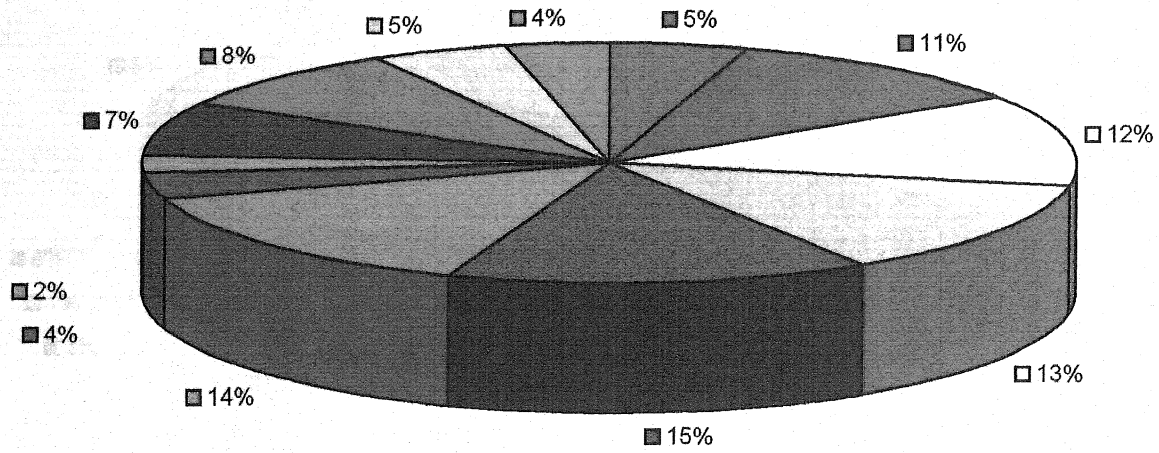
Oct 2 4 - - 3 4 4 17 14 8 6 8 6 42 3 4 10 2 5 24 15 17 8 6 6 52 135 Oct 6 5 - - 2 4 8 25 15 8 9 15 7 54 4 3 10 4 6 27 13 14

Nov 3 4 - 2 - 8 6 23 15 15 9 7 4 50 6 5 9 4 6 30 31 15 5 8 8 67 170 Nov 6 6 - - - 5 8 25 16 14 1 2 9 42 6 5 10 4 7 32 31 15

Dec 2 3 - 3 - 5 5 18 6 15 5 6 4 36 2 3 13 3 4 25 34 - 4 4 4 46 125 Dec 3 4 - - - 4 4 15 7 14 - - 3 24 3 3 11 2 3 22 35 -

Fig 66

Station IV
Zooplankton
2002



Jan 3 2 - 3 2 3 2 15 3 15 - - 3 21 2 5 7 2 3 19 4 -

Feb 4 4 - 3 3 6 4 24 6 6 3 - 5 20 3 10 20 2 4 39 6 -

Mar 6 5 - 6 4 10 5 36 16 11 2 - 6 35 4 12 25 8 7 56 8 -

Apr 6 9 4 6 6 13 8 52 20 17 2 - 13 52 8 24 32 10 9 83 24 10

May 8 10 6 7 6 16 10 63 26 19 6 - 16 67 7 22 47 12 10 98 30 7

Jun 11 10 6 11 8 19 14 79 28 22 3 6 18 77 3 14 9 12 14 52 18 4

Jul 2 2 - - - - 12 16 3 3 2 4 4 16 2 4 - - 3 9 22 -

Aug 1 1 - - - - 16 18 3 1 2 5 3 14 1 3 - - 1 5 4 -

Sep 4 3 - - 3 3 6 19 10 4 3 2 5 24 3 1 - 2 6 12 6 4

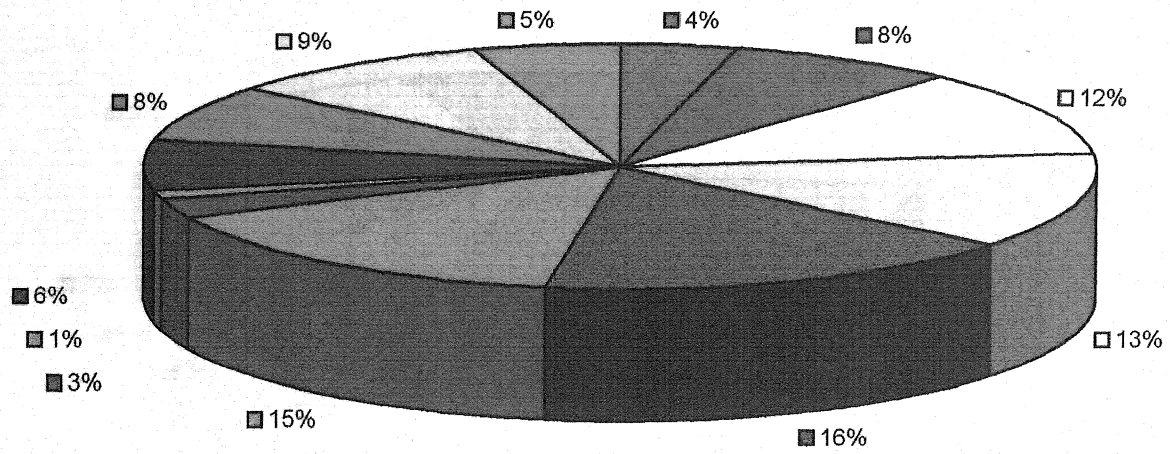
Oct 6 5 - - 2 4 8 25 15 8 9 15 7 54 4 3 10 4 6 27 13 14

Nov 6 6 - - - 5 8 25 16 14 1 2 9 42 6 5 10 4 7 32 31 15

Dec 3 4 - - - 4 4 15 7 14 - - 3 24 3 3 11 2 3 22 35 -

Fig 67

Station V
Zooplankton
2002



Jan 2 3 - 2 4 3 2 16 3 16 - - 2 21 2 5 7 3 2 4 -

Feb 3 5 - 3 4 5 3 23 7 6 3 - 4 20 4 10 26 4 5 5 -

Mar 6 7 - 5 6 8 4 36 14 10 2 - 6 32 8 13 25 8 8 9 -

Apr 6 8 4 7 6 12 8 51 18 16 1 - 10 45 8 23 30 10 10 23 10

May 9 12 8 10 6 14 12 71 22 20 6 - 16 64 6 21 47 13 12 30 5

Jun 12 12 8 12 8 18 16 86 25 20 6 6 16 73 3 14 8 13 14 20 4

Jul 1 2 - - - - 17 20 26 2 2 3 4 37 2 3 - - 2 21 -

Aug 1 1 - - - - 10 12 2 1 2 4 3 12 1 3 - - 1 4 -

Sep 3 4 - - 4 2 14 27 4 4 3 2 6 19 4 1 - 2 6 5 5

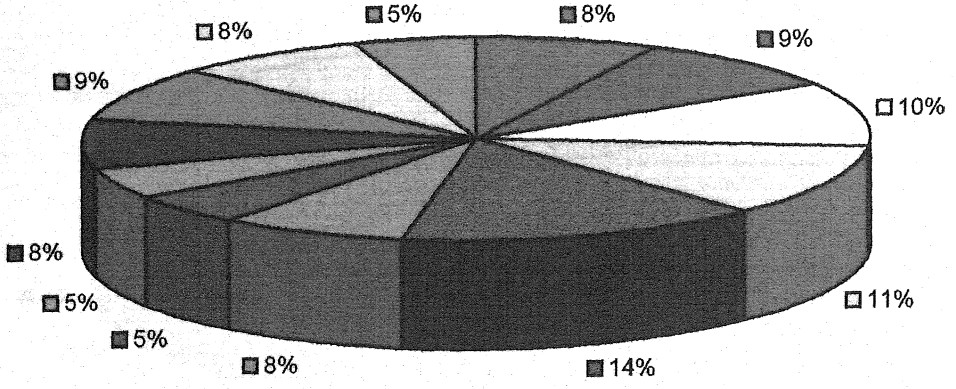
Oct 5 6 - - 4 5 5 25 8 6 9 14 7 44 4 3 9 4 7 14 16

Nov 6 6 - - - 6 8 26 14 12 1 2 8 37 7 5 9 5 7 34 14

Dec 4 3 - - - 3 7 17 6 13 - - 4 23 3 2 14 2 3 35 -

Fig 68

Station I
Zooplankton
2003



Jan 1 3 - 1 1 2 4 12 3 18 - - 2 23 1 6 8 1 2 18 5 - 6 7 4 22 75 Jan 2 3 - 2 1 1 3 12 4 16 - - 4 24 2 5 5 2 3 17 5 -

Feb 3 4 - 2 1 6 8 24 5 5 3 - 5 18 2 10 20 2 8 42 6 - 8 6 2 22 106 Feb 2 4 - 2 2 5 7 22 10 6 3 - 5 24 3 9 22 2 6 42 5 -

Mar 4 5 - 4 2 13 9 37 17 10 12 - 6 45 2 12 25 8 10 57 8 - 6 9 2 25 164 Mar 5 4 - 4 4 14 7 38 16 11 2 - 6 35 4 12 24 7 10 57 7 -

Apr 5 6 2 5 3 16 13 50 19 16 2 - 11 48 4 24 31 6 10 75 25 10 10 10 4 59 232 Apr 6 5 3 6 4 15 12 51 20 15 2 - 10 47 5 23 37 8 10 83 26 10

May 8 8 5 6 5 17 17 66 18 20 6 - 12 56 6 21 48 7 12 94 30 8 11 12 3 64 280 May 7 7 6 7 5 17 14 63 22 20 6 - 15 63 8 22 50 8 11 99 31 5

Jun 9 13 6 10 6 18 18 80 20 20 4 6 14 64 8 15 9 6 7 45 19 4 5 16 2 46 235 Fig 69 Jun 9 11 6 12 6 20 15 79 23 22 3 6 17 71 1 15 5 10 12 43 19 4

Jul 1 1 - - - - - 2 - 3 2 4 3 12 1 4 - - 6 11 23 - 3 4 - 30 55 Jul 2 2 - - - - 19 23 3 3 2 5 2 15 1 3 - - 3 7 22 -

Aug 1 1 - - - - - 2 - 1 2 3 2 8 1 2 - - 2 5 4 - 3 3 - 10 25 Aug 1 2 - - - - 15 18 2 1 2 3 1 9 3 2 - - 2 7 4 -

Sep 2 3 - - 1 2 2 10 7 5 3 2 4 21 2 1 - 1 3 7 5 5 5 7 2 24 62 Sep 2 3 - - 2 3 6 16 9 3 3 2 3 20 5 1 - 1 4 11 5 3

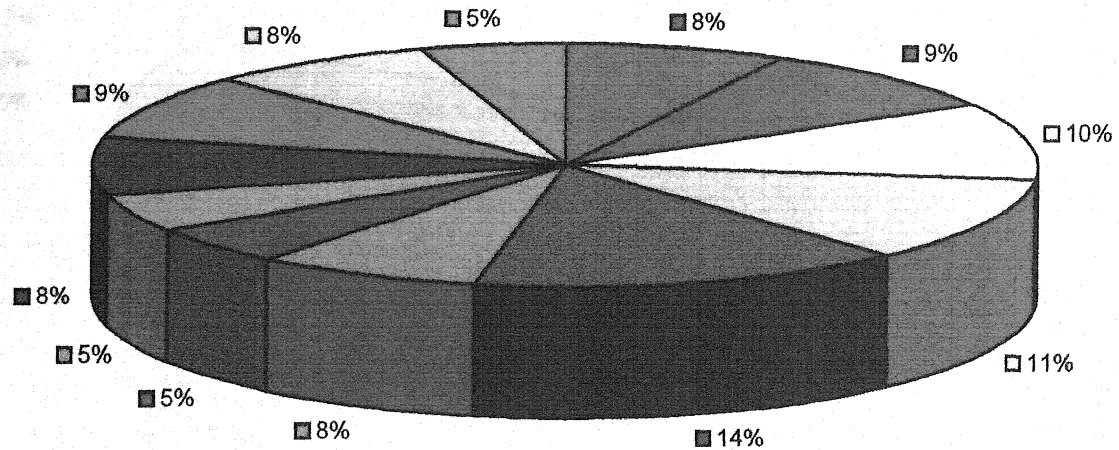
Oct 3 5 - 2 1 4 3 18 15 8 10 14 6 53 3 3 9 2 4 21 14 16 8 8 4 50 142 Oct 2 5 - - 3 7 3 20 12 8 10 14 5 49 5 3 5 3 6 22 15 15

Nov 3 6 - 2 - 6 6 23 16 13 1 2 5 37 4 5 10 2 6 27 33 15 9 10 6 73 160 Nov 3 5 - 2 - 6 8 24 15 13 1 2 4 35 6 5 15 4 5 35 32 13

Dec 2 3 - 1 - 3 4 13 2 15 - - 4 21 2 2 12 1 5 22 35 - 6 7 6 54 110 Dec 2 2 - 2 - - 2 8 3 16 - - 4 23 3 2 13 3 3 24 34 -

Fig 69

Station II
Zooplankton
2003



Jan 2 3 - 2 1 1 3 12 4 16 - - 4 24 2 5 5 2 3 17 5 -

Feb 2 4 - 2 2 5 7 22 10 6 3 - 5 24 3 9 22 2 6 42 5 -

Mar 5 4 - 4 4 14 7 36 16 11 2 - 6 35 4 12 24 7 10 57 7 -

Apr 6 5 3 6 4 15 12 51 20 15 2 - 10 47 5 23 37 8 10 83 26 10

May 7 7 6 7 5 17 14 63 22 20 6 - 15 63 8 22 50 8 11 99 31 5

Jun 9 11 6 12 6 20 15 79 23 22 3 6 17 71 1 15 5 10 12 43 19 4

Jul 2 2 - - - - 19 23 3 3 2 5 2 15 1 3 - - 3 7 22 -

Aug 1 2 - - - - 15 18 2 1 2 3 1 9 3 2 - - 2 7 4 -

Sep 2 3 - - 2 3 6 16 9 3 3 2 3 20 5 1 - 1 4 11 5 3

Oct 2 5 - - 3 7 3 20 12 8 10 14 5 49 5 3 5 3 6 22 15 15

Nov 3 5 - 2 - 6 8 24 15 13 1 2 4 35 6 5 15 4 5 35 32 13

Dec 2 2 - 2 - - 2 8 3 16 - - 4 23 3 2 13 3 3 24 34 -

Fig 70

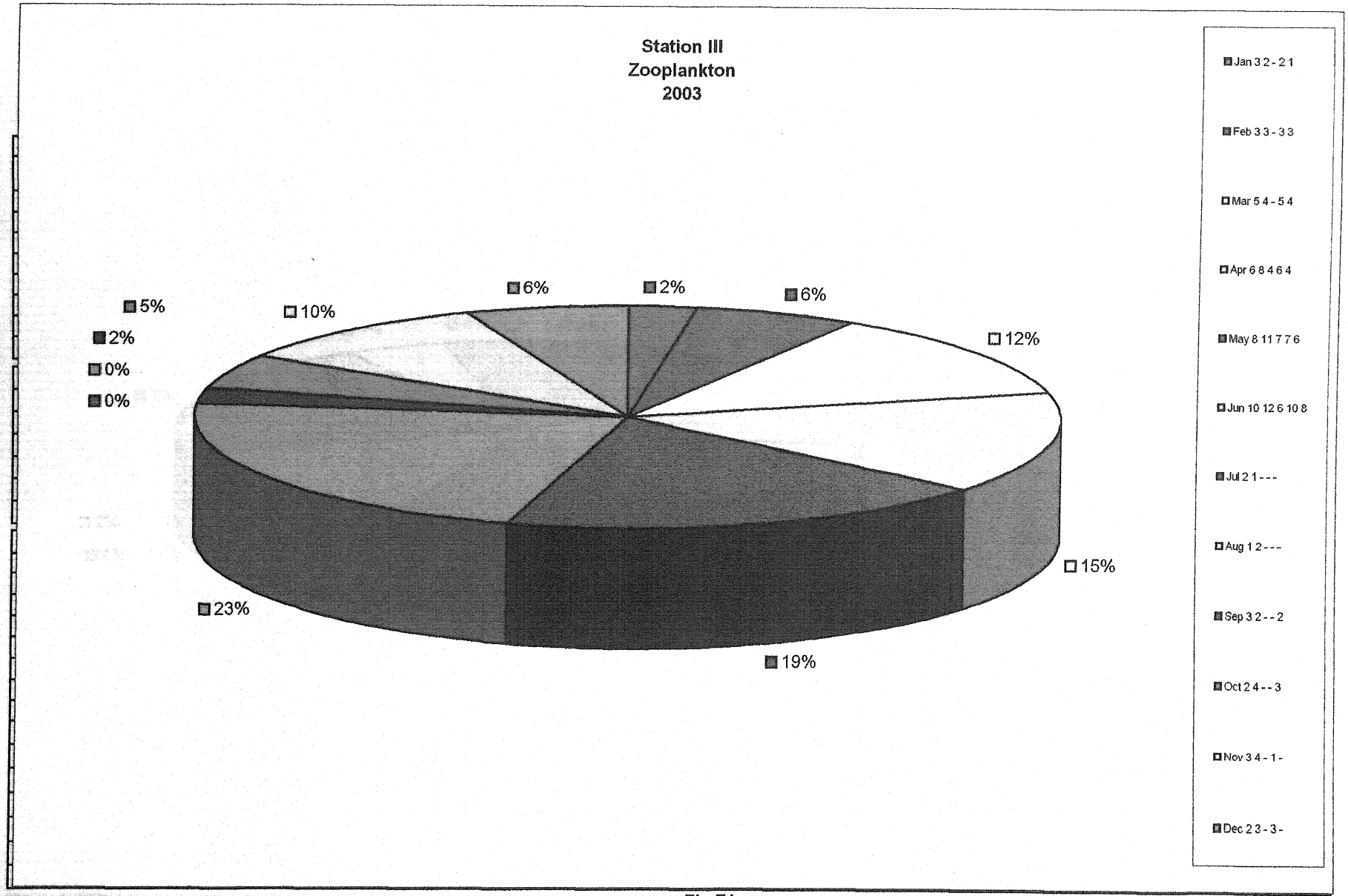
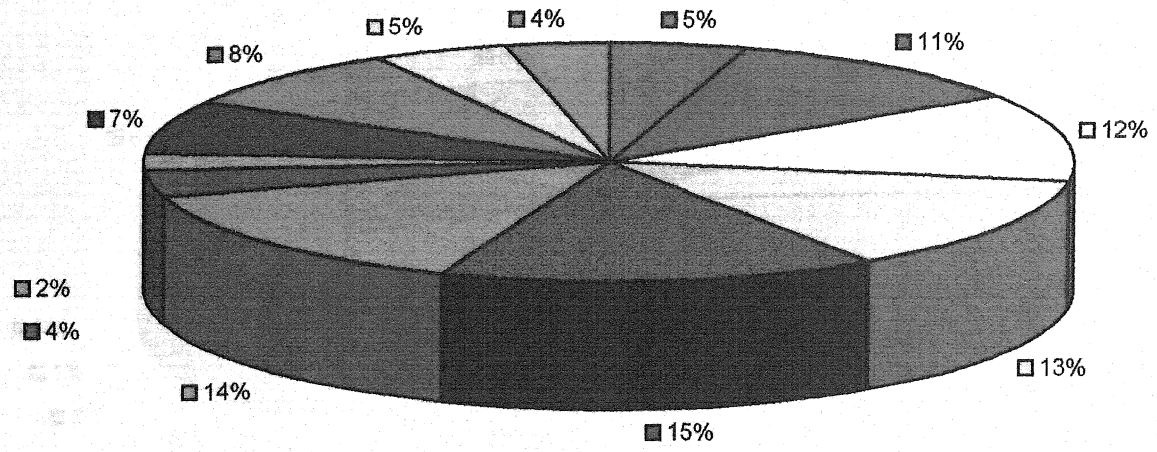

Station III
Zooplankton
2003
5%
2%
0%
0%
10%
6%
2%
6%
12%
15%
19%
23%
Jan 3 2 - 2 1
Feb 3 3 - 3 3
Mar 5 4 - 5 4
Apr 6 8 4 6 4
May 8 11 7 7 6
Jun 10 12 6 10 8
Jul 2 1 - - -
Aug 1 2 - - -
Sep 3 2 - - 2
Oct 2 4 - - 3
Nov 3 4 - 1 -
Dec 2 3 - 3 -

Fig 71

Station IV
Zooplankton
2003



Jan 2 2 - 2 2 3 2 13 3 14 - - 3 20 2 6 6 2 3 19 5 -

Feb 3 4 - 3 3 6 4 23 6 6 2 - 5 19 3 10 22 2 4 41 6 -

Mar 6 6 - 6 4 11 6 39 16 10 2 - 6 34 4 12 25 8 7 56 8 -

Apr 7 9 4 6 6 12 8 52 20 17 3 - 13 53 8 24 32 10 9 83 24 9

May 9 10 6 8 6 17 10 66 27 18 6 - 17 68 7 23 46 12 10 98 30 7

Jun 11 10 6 11 9 19 15 81 28 23 3 5 18 77 3 13 9 12 14 51 18 4

Jul 2 2 - - - - 12 16 3 4 2 4 4 17 2 5 - - 3 10 22 -

Aug 1 1 - - - - 15 17 3 2 2 5 3 15 1 3 - - 1 5 4 -

Sep 3 2 - - 3 3 6 17 10 3 4 3 6 26 3 1 - 2 6 12 6 5

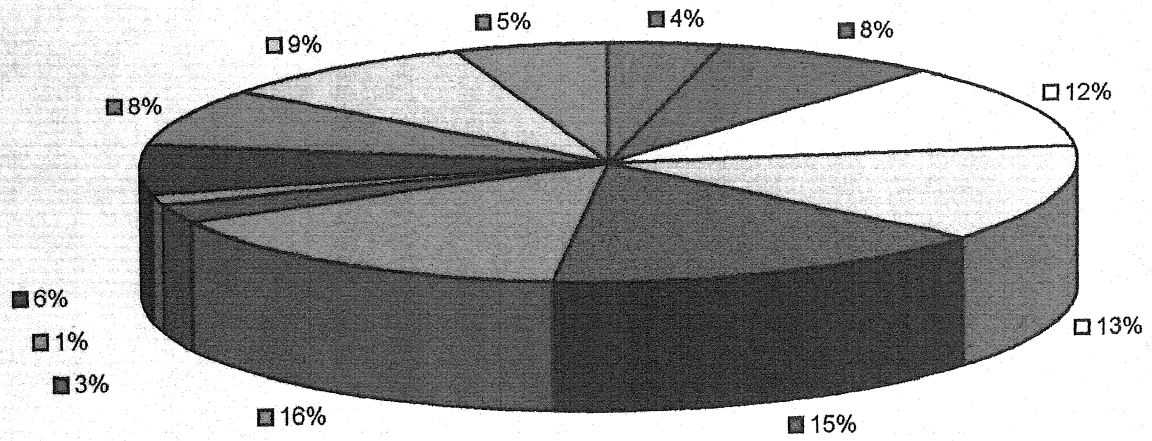
Oct 5 5 - - 2 4 8 24 16 7 9 15 8 55 4 2 10 4 6 26 13 14

Nov 7 7 - - - 5 8 27 15 13 1 2 9 40 7 5 9 4 7 32 31 16

Dec 3 4 - - - 4 1 12 7 14 - - 3 24 3 3 11 2 3 22 35 -

Fig 72
175

Station V
Zooplankton
2003



Jan 2 3 - 2 4 3 2 16 3 15 - - 2 20 2 6 6 3 2 19 4 -

Feb 3 4 - 3 4 5 3 22 7 5 2 - 4 18 4 10 21 4 5 44 5 -

Mar 5 7 - 5 6 8 4 35 14 10 2 - 6 32 8 13 22 8 8 59 9 -

Apr 6 8 4 7 6 12 8 51 18 17 1 - 10 46 8 23 30 10 10 81 23 9

May 9 12 8 10 7 14 12 72 22 19 6 - 16 63 6 20 47 13 12 98 31 5

Jun 12 11 8 11 8 18 17 85 25 20 5 5 16 71 3 13 7 14 14 51 20 4

Jul 1 2 - - - - 17 20 26 1 2 3 4 36 2 3 - - 2 7 21 -

Aug 1 1 - - - - 10 12 2 1 2 4 3 12 1 3 - - 1 5 4 -

Sep 4 4 - - 4 2 14 28 4 4 3 2 6 19 4 1 - 2 6 13 5 5

Oct 5 6 - - 4 5 5 25 8 6 9 14 7 44 5 3 8 4 7 27 13 15

Nov 6 5 - - - 6 8 25 14 12 1 2 8 37 7 5 9 5 8 34 34 14

Dec 4 3 - - - 3 7 17 6 13 - - 4 23 3 2 14 2 3 24 35 -

Fig 73

SUMMARY

SUMMARY

Water is the prime necessity of living beings because it plays an important role to sustain various forms of life on the Earth. It is available from the natural resources in the form of rivers, lakes, ponds, reservoirs, seas and even ground water. The most widespread source of water pollution in disposal of sewage of urban and rural centers in to the rivers. Pollutants also have potential effect upon the human health by drinking such water, which is especially on people who live in vicinity of such environment.

As regrds the unsuitability of water for the fish production and drinking purpose the various measures as regards irradication of weeds, various pollutants and soil erosion etc. are suggested to tone-up the river Ken so that the maximum fish production as well as suitability of water for drinking purpose might be done.

The river Ken is a hilly river which is its special feature in its topography. It total stretch from origin to confluence with the river Yamuna is 427 Km. out of which 292Km. lies in Madhya Pradesh, 84 Km. in Uttar Pradesh and 51 Km. forms the common boundary between U.P. and M.P. due to scattered towns of these two states nearby this river. A stretch of this river between Banda city to Chilla town is about 53 Km. was studied. The river basin lies between the latitude of $23^0$12' N. and $25^0$54' N. and the longitude of $78^0$30' E. and $80^0$36' E. Different types of sampling stations were selected to explore the pollution and micro and macrofauna. All the sampling stations are located between Banda city to Chilla town in Banda district. Station-I was selected in upstream near Rajghat, Station-II in down stream at cremation area. Station-III in Khaptiha village where discharge of two nala. Station-IV at Pailani town where Chandrawal river

confluences to Ken river at this station and Station-V at Chilla town where river Ken confluence into river Yamuna.

The quality of river water was investigated at five different sampling stations to find out the characteristics of water in reference of physo-chemical and biological factors.

The studies of various workers, journals, thesis, books, libraries references of intsuct related to this field have been scanned which have been mentioned in the review of literature. This work was studied in concern of physical, chemical and biological with particular emphasis for fish culture and drinking water. which is the primary need to solve the food problem as substitude of agricultural products and health hazards.

For the chemical and biological analysis of water samples were collected from all the above said stations. The chemical and biological analysis of water samples were done as per methods of APHA (1995) for the period of January, 2002 to December, 2003.

The Ken river was observed for physico-chemical and biological and various factors in the period of (Jan., 2002 to Dec., 2003) study. The factors which are Atmospheric temperature, Relative humidity, Photo period, Water current, Turbidity, Rainfall, Light penetration, pH, D.O., B.O.D., C.O.D., Total alkalinity, Total hardness, Chloride, Co_2, Phosphate, Sulphate, Ammonical Nitrogen, Total Coliform (MPN), Plankton (Phyto and Zooplankton), Aquatic weeds and Fish fauna were studied in the present work.

Metereological data i.e. atmospheric temperature, photo period, relative humidity and rainfall were recorded for the period of January, 2002 upto December, 2003.

During the period of two years study atmospheric temperature ranged from 6.3^0c to 41.45^0c. The maximum temperautre in the month of June and minimum in January were recorded the photo period was found to be maximum in the month of June (13.34hrs.) and minimum in December 10.07hrs. It was recorded in different seasons. The atmospheric temperature showed positive relationship to photo period whereas relative humidity was also positively related to the rainfall. It had also impacts negatively on atmospheric temperature. All the metereological conditions have directly influence on the water characteristics of the river Ken.

The physical factors related to the water body are : Water temperature, Water current and Turbidity. They were studied in river Ken during the period of 2002-2003.

Water temperature was recorded to be maximum in the month of June (31.32^0c) and minimum in January (14.00^0c) during both the years. It is directly related to the atmospheric temperature. The seasonal changes in water temperature affected the chemical and biological characteristics of the water

Water current of the river was affected by wind velocity and rains also. The highest value of water current 1000.9Cum./Sec. was recorded at Station No.-I in August, 2002 and the second year in 2003, this highest value recorded at station -I, III and IV in the month of August, September and August respectivily. The variation are due to flood in span of the river. The fast water current adversely affects in fishing.

Turbidity of river water ranged from 24.0 to 77.0 N.T.U. during the first year in 2002, and 25.0 to 78.0 N.T.U. in the second year (2003). The highest value of turbidity 78.0 N.T.U. was recorded at station-IV in August 2002. The higher value was in summer due to silting, high wind velocity whereas in monsoon, contamination of organic matter through surface run-off. The mean value of turbidity during the study period ranging from 48.66 to 49.50 N.T.U. during both the years of study. It is increased in the rainy and summer season. Hence it is directly related to rainfall and wind velocity in respective seasons. This factor is negatively related to photosynthesis and zooplankton activities.

The chemical factors were taken for the study : pH, T.A., T.H., Cl, NH_4-N, D.O., B.O.D., C.O.D., Co_2, Po_4 and sulphate these were studied from January, 2002 to December, 2003 in the period of study.

The pH of river water ranged from 7.49 to 8.20 with a mean value of 7.80 to 8.80 in both the years of study period. Minimum pH value was noticed at station-II and maximum at station-I. Higher pH value in summer was due to the utilization of free carbon-di-oxide during active photosynthesis and minimum value was recorded during winter season due to dissociation of carbonic acid (H_2CO_3). At station-I, II, III and IV pH value should minor variation whereas (station-V) has major in comparision to other stations difference due to more organic materials and drainage through Nala from Chilla town. Besides it is a confluence point were this Ken river joins the river Yamuna at this station. Hence the water is more alkaline there. The impact of pH values which causes water either acidic or alkaline. The water was found alkaline throughtout the study which is favourable for fish productivity. pH is directly related with total alkalinity and inverse relationship with Co_2 was also observed.

Total Alkalinity is produced by anions mainly carbonatates, bicarbonates and hydroxyl-ions. The value of total alkalinity varied from 120 to 173ppm. The

mean value of 120 to 172.5ppm. was found in both the years. The minimum value of alkalinity was found during winter season (January) at station-III, IV and V in both the years due to water infested with aquatic plants and low pH. The high value of total alkalinity was observed during summer season due to low level of water, concentration of carbonets alongwith high decomposition of organic matter at station-I in June. A significant positive correlation was found with pH at most of the sampling stations during investigation which shows positive relationship with productivity of water.

The value of hardness in the river water varied from 80 to 162ppm. during both the years of study period (2002-2003) and the mean value of hardness ranged from 120 to 172.5ppm. The minimum value of hardness observed at station-V in the month of August during both the years due to more dilution of water, less evaporation, exchange of sodium ions and concentration of calcium is reduced at higher pH due to its precipitations as calcium carbonate. The maximum value of hardness was found at station-I in June both of the years due to joins of sewage nala of city Banda. The findings of hardness in river water reveles that water was comparatively hard at station-I and II, than other stations. The significant variations were found in summer and post monsoon period, whereas it was higher to some extent at station-III and IV. This variation is due to the more rocks formations at station-I & II, less at station-III & IV and absent at station-V and anthropogenic activities of the holy fairs arranged there. A positive correlation was found with T.A. at most of the stations during study period.

The chloride concentration was found in the range of 12.00 to 49.00ppm. In the year 2002 it ranged 14.00 to 49.00ppm while in the year 2003 between 12.00 to 49.00ppm. at different stations. The mean value of chloride during the study period of 2002 varied from 33.00 to 33.50 ppm and in 2003 ranged from

32.00 to 33.75 ppm at different monitoring stations. The highest concentration was observed at station-I and II in May during both the years. due to addition of domestic waste, sewage and municipal wastes in to the river. Higher value of chloride also recorded at station-IV due to washing, bathing and other extraneous sources. The lowest value of chloride was observed at station-III in August, 2003 due to entrance of plenty of water and dilution effect in rainy season. An inverse relationship between the chloride concentration and the water level was also found. Besides, the chloride contents showed direct relationship with phytoplankton and inverse relationhip with zooplankton. High amount of chloride increase by animal excreta which increases faecal pollution in the river water.

The river water showed good Dissolved oxygen value varying from 6.74 to 8.93ppm. in the year 2002 and between 6.75 to 8.93ppm. in 2003 at different sampling stations. The mean value of Dissolved oxygen during the study period 7.79 to 7.89ppm. the highest value of D.O. was observed during winter season due to low temperature, and much water quantity whereas lowest value recorded in summer season in the month of June due to high temperature and low water level which decreases the oxygen holding capacity of water. The D.O. value shows negative correlation with the water temperature at all the station due to bacterial activities by which B.O.D. increases and D.O. decreases. The D.O. is positively related with the photosynthesis which is perform by flora. An inverse relationship was found between dissolved oxygen and Co_2. The Zooplankton also showed negative relationship with D.O. whereas direct relationship of D.O. with phytoplankton was observed. D.O plays very important role in physilogy of biota. Obviously it is positively related with the production of fishes. Hence D.O. is optimum parameter of the water.

The value of B.O.D. in the river water varied from 1.00 to 2.50ppm. in the year 2002 and between 1.00 to 2.40 ppm in 2003 at different sampling stations. The mean value of B.O.D. during the study period was 1.73 to 1.82ppm.. The

maximum value of B.O.D. was noticed in June 2002 at station-I and II due to city sewage, waste pollution and high temperature whereas minimum value of B.O.D. of observed in September at station-V because of more dilution of water and self reoxygenation process during the course of its flow upto last station and also due to low temperature. B.O.D. showed significant positive correlation with temperature most of the time. It is noticed that B.O.D. is directly related with chloride and bacterial activities whereas B.O.D. shows inverse relationship with D.O.. Hence high B.O.D. is the indicator of water pollution which will adversely effect fish fauna and drinking water quality.

The C.O.D. value varied from 6.40 to 13.90ppm. in the year 2002 and between 6.30 to 14.00ppm. in 2003 at different sampling stations during the study period. The mean value of C.O.D. during the study period of in 2002 varied from 9.59 to 9.56ppm. and in 2003 it ranged from 9.35 to 9.55ppm. at different sampling stations. The desirable limit of C.O.D. is 10ppm. in drinking water as recommended by W.H.O.. During the investigation the highest value was observed in summer season at station-I and II due to high temperature, low water level and much organic concentration whereas lowest value was in rainy season due to dilution of water, low temperature and less density of organic matters. The C.O.D. showed positive correlation with B.O.D., temperature and the load of organic matters at most of the stations. B.O.D. and C.O.D. are the indicator of water quality. It is helpful in indicating toxicity of water which will be harmful for aquatic biota as well as health hazards by drinking such water.

Ammonical nitrogen concentration varied between 0.01 to 0.12ppm. in the year of 2002 and ranged from 0.01 to 0.13ppm. in 2003 at different sampling stations. The mean value of ammonical nitrogen during the study period of 2002 varied from 0.03 to 0.04ppm. and in 2003 varied from 0.04 to 0.05ppm. at different sampling stations. The maximum concentration of ammonical nitrogen was observed in summer season in the month of June due to much decomposition of organic matter, animal excreta, high alkalinity and high temperature whereas minimum concentration was noticed in the month of August due to dilution of organic matter by rain water. Hutchinson (1957)

investigated that summer maxima of ammonia concentration was also observed in May and June. It first converts into nitrite later in nitrate nitrogen. This factor is strong positively correlated with phosphate. Hence it is also directly related with productivity of the water.

Carbon-di-oxide concentration ranged from 1.6 to 4.6ppm. in the year 2002 and between 1.5 to 4.7ppm. in 2003 at different sampling stations. The mean value of Co_2 during the study period of 2002 varied from 2.8 to 2.97ppm. and in 2003 ranged from 2.84 to 3.04ppm at different sampling stations. The highest value of Co_2 was observed in summer season in the month of June at station-I and II due to nala sewage high decomposition of organic matter animal excreta at high temperature and respiration of living organisms whereas lowest value of Co_2 recorded in winter season in the month of January at station-V due to low decomposition of organic matter, low temperature and much water quantity. The concentration of carbon-di-oxide showed an inverse relationship with dissolved oxygen and pH value, while significant positive correlation with water temperature and C.O.D. in the present investigation. The carbonates and photosynthetic activity showed inverse relationship with carbon-di-oxide concentration whereas the bicarbonates have direct relationship. High Co_2 causes unsuitability of the water.

The level of phosphate content was recorded between 0.17 to 0.56ppm. in the year 2002 and in 2003 varied from 0.17 to 0.57ppm. at different sampling stations. The maximum concentration was observed at station-I and II in August 2003 due to agricultural run-off and sewage which cause eutrophication whereas minimum concentration was noticed at station-IV and V due to lack of discharge. At the station-III and IV some higher concentration of phosphate was found

due to discharge of domestic wastes and sewage. The mean value of phosphate during study period of 2002-2003 was found in the range of 0.12 to 0.31ppm. from different sampling stations. Phosphate is the limiting factor as its difficiency lowers the productivity of aquatic flora it is positively related with ammonical nitrogen and total alkalinity. High concentration of phosphate will result the water body weed infested.

The concentration of sulphate was found in the range of 1.74 to 4.53ppm. in the year 2002 and between 1.65 to 4.67ppm. in 2003 at different sampling stations. The mean value of sulphate during study period of 2002 ranged between 2.75 to 2.77 ppm and in 2003 varied from 2.74 to 2.81ppm at various sampling stations. The highest value was observed in summer, season at June month at station-I, II and IV in 2002 and at station-I and II in 2003, due to deposition of westes and presence of rocks whereas minimum value observed in rainy season in the month of August at station-III, IV and V in 2002 and in 2003 at station-II due to high quantity of water body and dilution. Its concentration is effected by domestic sewage. The sulphate showed positive correlation with C.O.D., T.H. and ammonical nitrogen. Much concentration of sulphate will result the water unuseful.

Regarding, biological characteristics of river Ken the MPN, flora (micro and macro) and fauna (micro and macro) were studied which are phytoplankton and zooplankton, total coliform (MPN), aquatic weeds (submerged, free floating and submerged floating), phytoplankton, zooplankton, economically important fishes and hill stream fishes.

MPN of coliform organisms fluctuated from 55 to 1602/100ml. in the year 2002 and between 52 to 1606/100 ml. in 2003 at different

sampling stations. The mean value of MPN during the study period of 2002 varied from 207 to 323.66/100ml. and in 2003 ranged from 200.5 to 324 .41 /100 ml. at different sampling stations. Maximum count of bacteria was noticed in summer and monsoon period at station-I, II and III due to temperature conditions, pollutants run-off and sewage from nearby area as a result of the washing of soil and organic matter etc. While minimum count was observed in January at station-I, IV and V due to low temperature and lacs of run-off. Total coliform showed significant positive correlation with temperature turbidity and phosphate at most of the stations. Desirable limit of coliform should be zero number/100ml. in drinking water (W.H.O.). This is directly correlated with the pollution.

The phytoplankton were observed qualitatively and quantitatively which are belongs to the group of Chlorophyceae, Bacillariophyceae and Mixophyceae (Cyanophyceae). Phytoplankton of the river is generally composed of a wide variety of forms that are the greatly affacted by the surrounding environment. Discharge of sewage wastes drastically change the quality of water and consiquently the composition of phytoplankton. The plankton was quite abundant in the Ken river during month of June and in the winter month of October and November whereas the lean period was recorded during mansoon period of July, August and September. The phytoplankton constituted the major part of the total plankton. These are constituted about 64.0% and 64.6% of the total plankton quantity during the first and second year respectively. The density of phytoplankton impart colour to the water. Ocillatoria is more responsible for eutrophic conditions. Phytoplankton directly correlated with ammonical nitrogen and phosphate.

The zooplankton were comprised of protozoa, rotifera, copepoda and cladocera. They are constituted 36.0% and 35.4% of total plankton

during first and second year respectively in the period of study. Protozoa were noticed qualitatively 7 genera mainly they ranged between 2 org./l. to 86 org./l. these are found very rare in number at most of the stations, Rotifera were observed 5 genera, mostly they have seen in summers. They increased gradually from spring to summer but in winter it was sporadic. Rotifers co-related with higher alkalinity and temperature condition. The density of Rotifers found higher than total zooplankton. They were observed in the range of 9 org./l. to 94 org./l. in the investigation period, their maximum number were seen in the month of June due to high turbidity and organic discharge by sewage at station-I and II.

Copepode and Cladocerans indicate the incidence of organic pollution (Anthony et. al., 1979). They were observed 5 genera each. Cladoceran ranged 4 org./l. to 99 org./l. in both year of the study, whereas Copepode investigated 7 org./l. to 71 org./l. in 2002 and in 2003 it found 7 org./l. to 73 org./l..

Copepode and Cladocerans dominated during monsoon whereas Rotifers dominant during summer. Copepode and Cladocerans found maximum in rainy season due to high turbidity and high alkalinity.

The summer peak of zooplankton might be due to high temperature, which stimulate the reproduction and development of zooplankton. Higher pH, alkalinity and some other important nutrients during summer have directly or indirectly favoured the development of zooplankton population. Phytoplankton serve as food of zooplankton and their abundance during summer season may have enhanced the population of the zooplankton in the river. They are positively related

with phosphate and ammonical nitrogen and diurnal fluctuation of zooplankton so positive relationship with photo period and temperature.

The aquatic weeds of the river Ken were examined during both the years of study period (2002-2003). It was observed that the free floating species are Lemna paucicostata, Trapa bispinosa, Eichhornia crassipes, Azolla species etc. are found and their growth started from October and made scum in shore region and they began to deplete from April onwards whereas submerged species Potamogeton spp. found very small in number which is disappeared in monsoon period. Ceratophyllum, Hydrilla and Vallisneria are the most abundant on station-IV and V. This density becomes less in monsoon period while Vallisneria occured in shallow regional station-III.

Free floating forms were predominate at some places and easily spread to other parts, Lemna spp., Spirodella spp. and Azolla spp. colonise at such places where river forms side pools at station-II and IV appearing almost stagnant. Dense growth of Eichhornia spp. cover tributries, nala and lowland impoundment arround the river. These areas of weed propagation functions as permanent sources of drifting vegetation which enters the river at the time of flooding. The colonies of connected rosettes of Trapa spp. are usually seen cultivated along the river by the local inhabitants.

Submerged and floating forms were maximum coverage in deeper parts of the river where they block it and reduce the flow of water. Hydrilla spp., Ceratophyllum spp., Nechamandra spp., and Potamogeton spp. all forming mixed associations. Marselia, Chara and Nitella spp. form subaquatic meadows in the marshy and shallow

isolated channels at stations-II and IV. Otellia spp. is rarely seen totaly submerged but is found only at shallowest part at station-III. They were observed throughout the period of study. Their prolifically growth chocke many rivers, irrigational canals, lakes and ponds.

The economically important and hill stream fishes were dragged out and studied during the period of study. The present investigation revealed that various fishes of economic values and hill stream fishes are found in the river Ken inwhich 38 spp., 28 genera, representing 14 families were studied in river Ken. Labeo rohita, Cirrihinus mrigala, Mystus seenghala, Xenantodon cancila, Clarius batrachus and Heteropneustes fossilis were more abundant in river Ken during the period of study (2002-2003).

The Ken river has generally a bed of coarse brown sand but some places the banks of muddy and have vegetation. The station-I which is in upstream near Rajghat is shallow and very less number of fishes are found and at station-V which is the confluence of Ken and Yamuna, have more fish than the other selected stations due to deepness of river, as much water facilitate fish movement.

The fish fauna of Ken river is characteristics in having hill stream fishes i.e. Garra gotyla, Lepidocephalichthyes guntea etc.. The presence of these fishes has own speical feature because of hilly origin and it is advantageous for research work which might be carried out on these hill stream fishes at plains. Besides, these fishes have also medicinal value. These fishes are of food value. But the fishes are not quite abundant which indicate that this river Ken has not been managed

scientifically for the proper fish production for which the measures are suggested.

Conclusion, Aim and Measures

On the basis of the present investigation of river Ken which can be used as in ideal fish farming as well as good drinking water quality. Some scientific measures which are proposed here after summerising all the characteristics of water. As it is perennial water strear, water is alkaline but at the some stations pollution was found. The plankton were quite abundant which enable the water considerably productive. But the river Ken is shallow, due to which the fish fauna is not rich.

Further, for the drinking purpose the water of rivek Ken can be used more suitable with some scientific measures because the river to some extent is polluted.

The main aim of study is to investigate the river water as regards more production of fishes and for the suitability of drinking purpose. Regarding this some scientific measures are being suggested in the above light. Which are :-

(1) Sewage wastes should be treated in the treatment plants to avoid the pollution in the river water. Thus the water will be suitable for drinking.

(2) Aquatic weeds should be removed time to time so that the water in facilitating circulation and free movement of fishes as well as fishing.

(3) As the river is shallow which has sandy bed is quite valuable. So if the proper digging of this sand is done by providing large contracts to digup this sand which will make river more deeper.

Besides it some small checks are made then the river will retain more water throughout the year with the result it will provide much productivity further by the digging of the sand the revenue to the Government will be increased.

By taking the above measures the physico-chemical and biological characteristics of the river Ken will suitable with reference to drinking water quality and fish productivity. Hence it will be quite fruitful.

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